Emergency Surgery

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BY

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SECOND EDITION

WITH 812 ILLUSTRATIONS OF WHICH A LARGE NUMBER ARE IN COLOUR

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To my Masters

Russell Howard
The late Frank Kidd
Hugh Lett
Ernest Charles Lindsay
Robert Milne
Sir Hugh Mallinson Rigby
James Sherren
Sir James Walton
The late Frank Jeans
Robert Ernest Kelly
Thomas Caldwell Litler-Jones
The late William Thelwall Thomas
Edward Deanesly
Hubert Maitland Turnbull *(Pathology)*
William Wright *Anatomy*

this work is dedicated in token of gratitude

PREFACE TO THE SECOND EDITION

EMERGENCY SURGERY now appears in one volume, which has obvious advantages. The text has been revised thoroughly, and in some sections has been rewritten. It has been my aim to provide a manual to which the surgical practitioner can turn when he himself must deal with an acute emergency. When to operate, when not to operate, and how to operate under emergency conditions, is the theme.

This was the first book I set out to write, but it was not the first to appear. I have always been conscious of the great responsibility entailed in writing a work of this nature. So much was this the case that I sought appointments which would provide me with the necessary experience rather than those of a more academic and progressive character. Even so, it is extremely doubtful if this book would have been finished if it had not been for the help of my wife.

Mr. N. M. Matheson rendered invaluable aid in reading all the proofs, and I am also indebted to Mr. J. B. Oldham for similar services. Mr. A. J. C. Latchmore has assisted in bringing the chapter on Burns up to date. Most of the new illustrations are from Dr. Crump's masterly pencil.

The unrivalled excellency of Messrs. John Wright and Sons Ltd. in production will be noted, especially in some of the coloured plates.

<div align="right">HAMILTON BAILEY.</div>

London, January, 1936.

FROM THE PREFACE OF THE FIRST EDITION

WHILE writing the present volume I have pictured a patient stricken with an urgent surgical condition and a comparatively isolated surgeon called upon to carry out appropriate treatment. Should these pages help the latter to save the former, their main object will be fulfilled.

The teachings of my Masters are its foundations; practical experience gained in widely separated surgical centres is its scaffolding; while the building material comes from my case index. Every case which I have been called upon to treat, and, earlier in my career, every important case at which I assisted, has been written up and indexed.

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"A true surgeon is never fearless. He fears for his patients, he fears for his shortcomings, his own mistakes, but he never fears for himself or his professional reputation."

<div align="right">(<i>Samuel J. Mixter.</i>)</div>

EMERGENCY SURGERY

INTRAVENOUS INFUSION

INTRAVENOUS infusion given in a massive single dose (a pint or more) has many times saved life. True. saline and other isotonic solutions are but a poor substitute for whole blood. but occasions arise when urgency forbids the delay inseparable from blood transfusion.

Fig. 1. — Funnel and tube in readiness for an intravenous infusion. Some fluid has been allowed to escape from the nozzle in order to be certain that there is no air in the tube.

When a patient is collapsed his veins will be in a like condition, and it is necessary to insert a cannula into the vessel.

E. S. 1

Technique.—Fill the funnel and tube with the solution before commencing to expose the vein. To ensure the absence of air in the tube and nozzle some fluid is permitted to escape. As soon as airlocks and bubbles are eliminated the tube is clipped (*Fig.* 1).

Place a rubber catheter, or the special vein tourniquet shown in *Fig.* 2, around the arm. If the veins in front of the elbow are not visible, milk the venous blood upwards from the wrist. Place a folded towel beneath the elbow to hyperextend the
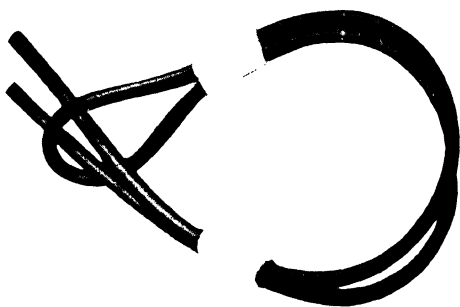
Fig. 2. An excellent form of vein tourniquet. It is made from a length of ⅛-in. drainage-tube and adhesive plaster. It releases itself automatically when tension on the ends is relieved.

joint. If the patient is conscious, inject a little local anæsthetic into the skin over the vein. With dissecting forceps pick up the skin so as to make a longitudinal fold over the vein. With the scalpel held horizontally incise this fold (*Fig.* 3). This will result in a V-shaped cutaneous incision. Catch the apex of the V in a hæmostat and retract it. A little dissection in the wound will reveal a vein. With dissecting forceps gently pick up the front wall of the vein and dissect its under surface with the probe end of a Watson-Cheyne dissector. Beneath the vein pass two catgut ligatures. Tie the distal ligature and cut the ends short. Once more pick up the anterior wall of the vein with dissecting forceps. Ask the assistant to remove the tourniquet, then incise the vein with the scalpel
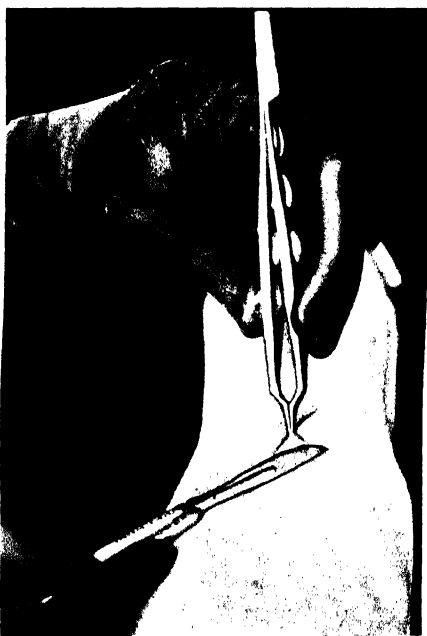
Fig. 3. Method of incising the skin to expose a vein at the fold of the

held flat. Continue to hold up the anterior wall of the vein (*Fig.* 4) until the nozzle (through which saline is now running) is within the lumen, then tie the proximal ligature round the vein and the nozzle

Fig. 4.
at the fold o
for the inserti   nula

within it. After the administration, as the last ounce of fluid is gravitating into the vein, the cannula is withdrawn and the ligature surrounding the vein tied quickly. Two skin sutures are required to complete the operation.

CONTINUOUS INTRAVENOUS INFUSION

Useful as is the massive dose of intravenous saline, the indications for its use are limited. It must be borne in mind that unless there has been a corresponding loss it is manifestly unphysiological to put into the circulation a pint of fluid more or less suddenly. Both the four-hourly and the continuous rectal drip are eminently satisfactory in many, if not most, instances, and it is not suggested that the continuous intravenous infusion should supersede them. I have, however, discontinued giving saline subcutaneously. In shock, dehydration from vomiting, oliguria, and many forms of toxaemia, a slow continuous flow of saline intravenously approaches the ideal, for we know exactly how much fluid the patient is receiving. The fluid can be given over a period of three to five days, or even longer, and the rate of flow and the amount of fluid can be regulated with mathematical precision.
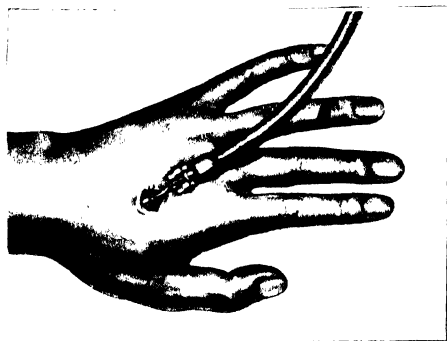
Technique.—
Choice of the Vein.—In general it is best not to use a large vein; one just a little larger than the cannula or the needle is most suitable. The veins about the elbow

are too large, and the impracticability of keeping the elbow extended
and at rest for days rules out this favourable site for intravenous
injection.   Gallie and Harris prefer to use a vein on the back of the
hand (*Fig. 5*).   A vein on the back of the radial side of the forearm
(*Fig. 6*) is a particularly good one for general purposes.   Especially
when the vein can be made to stand out, this is the ideal situation
for an intravenous needle, as opposed to a cannula, to be inserted.
A possible disadvantage of employing veins of the lower extremity is

*Fig. 6.—A vein on the radial side of the forearm
when a   as opposed to a cannula c*

that after fluids have been injected into them they are prone to
thrombosis.   However, experience shows that when isotonic solutions
are employed and particularly when glucose is in a concentration
of not more than five per cent the fear of producing thrombosis is
largely theoretical.   For extremely ill patients who are restless, or
who may become so, I prefer to tie the cannula into the saphena
or one of its branches, a handbreadth below the knee, or, better
still, when it is accessible, the vein just in front of the internal
malleolus.   After infiltration with local anæsthesia the vein is exposed
conveniently by a transverse incision.

Apparatus.—Special needles and cannulæ for continuous intravenous infusion are available. The ones shown in *Fig.* 7 will be found satisfactory. The cannula or needle should be moist with
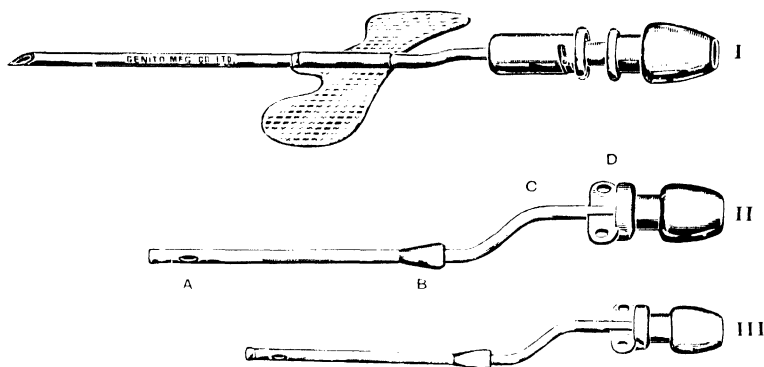
Fig. 7. I, Needle for inserting into a vein by a puncture. Once it is in place satisfactorily it is kept at rest by a strip of adhesive plaster across each wing, the limb being placed usually upon a splint. II, Cannula for veno-clysis. It is gold-plated to prevent corrosion. There are two lateral holes (A) in addition to the terminal opening. The collar B allows the straight portion of the cannula to be tied into the vein snugly. The sloping neck C can be bent to any angle suitable for varying depths of subcutaneous fat in individual cases. The perforations in the wings D permit anchoring the apparatus to the skin by means of sutures. III, Cannula, child's size. This can be used in any individual with small veins. The needle and cannulæ should be replated when they become tarnished.

citrate solution at the time of introduction. An interceptor (*Fig.* 8) is a necessary part of the armamentarium. Especially when it is new, the tubing should be stretched thoroughly along its length, washed through, and boiled prior to assembling the apparatus. Before use the whole of the apparatus must be sterilized by boiling.

Isotonic Intravenous Salines. The fluid most generally used is glucose-saline. Ringer's solution is a good substitute. Both these can be obtained in 50-c.c. ampoules, from Crookes Laboratories and other firms, with instructions for dilution. The water used for making intravenous salines should be freshly distilled. If it is desired to administer intravenous medication or sera the appropriate dose is mixed with the fluid in the supply flask.

The Temperature of the Fluid.—It is unnecessary to be concerned about the temperature of the fluid entering the vein. It is better to keep the patient warm with hot water bottles than to have an elaborate apparatus

Fig. 8.—An interceptor. (*Crookes Laboratories.*)

to maintain the temperature of the fluid in the container. Clearly, by the time any fluid has traversed the tubing it will be about room temperature on entering the vein. To place an electric heating pad or hot water bottle near the limb is more rational, and far more effective, than trying to maintain the infusion at blood heat.

Rate of Flow.—The average rate of flow for an adult should be about fifty drops per minute—that is, roughly, a quarter of a pint per hour. In cases in which it is necessary the rate can, for the first hour, be increased or decreased to suit individual requirements. The nurse should be told to keep a watch for signs of œdema under the eyes or in the limb, which is the signal that the amount of fluid entering the vein should be reduced.
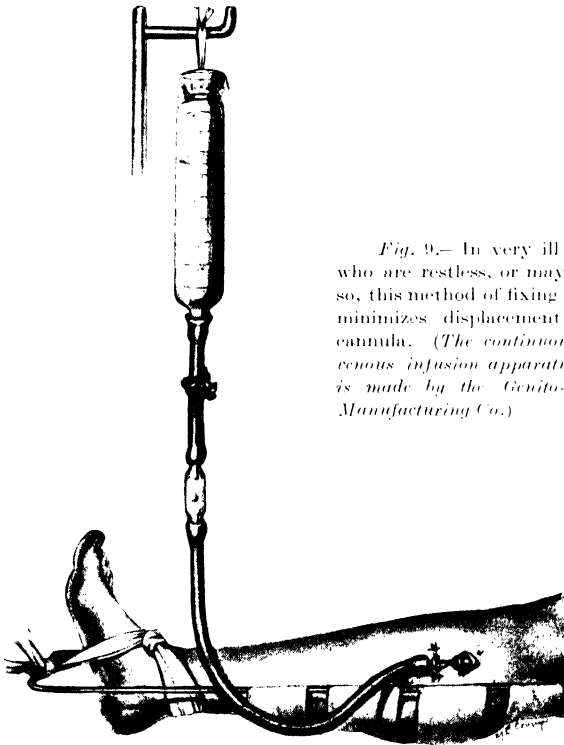
Fig. 9.— In very ill patients who are restless, or may become so, this method of fixing the limb minimizes displacement of the cannula. (*The continuous intravenous infusion apparatus shown is made by the Genito-Urinary Manufacturing Co.*)

Keeping the Limb at Rest.—If a vein of the forearm is used a light anterior splint is employed to immobilize the upper limb. Dickson Wright's splint (*see Fig.* 23, p. 23), is ideal for this purpose. When the lower extremity is selected a back splint with a foot-piece usually

answers the purpose. In a restless patient a Thomas knee-splint (*Fig.* 9) is a good method of ensuring that the cannula does not become displaced.

Bandages. It is obvious that even a moderately tight bandage proximal to the cannula may obstruct the vein. The nurse should be warned of this possibility when adjusting the splint.

How Long can Venoclysis be Continued? Three, four, or five days is quite usual. It is not exceptional to have the apparatus working satisfactorily for a week. After the fourth day redness over the vein, extending for a few inches above the site of the injection, may be expected. This should cause no alarm, for it is chemical phlebitis, which settles down in a few days after the withdrawal of the cannula. The nurse should be warned to keep a watch for this sign. Considerable redness may call for the changing of the cannula to another vein.

Special Instructions to the Nurse in Charge.—It is essential that the supply flask be kept at least half-full. If, through neglect, the flask has become empty it must not, under any circumstances, be refilled. The nurse should be instructed to report at once if the flow ceases. On no account must the tube distal to the interceptor be pinched ; this produces an air lock, and instead of enhancing the flow it is the very thing to stop it. Unless the latter instruction is stressed I have found that the nurse is very prone to carry out this manœuvre.

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CHAPTER II

BLOOD TRANSFUSION

Dangers of Transfusion. — From the headquarters of the British Red Cross Transfusion Service we learn that in a series of 3430 transfusions there were 5 deaths due to the transfusion.

Incompatibility. Inadequate compatibility tests were responsible for 3 of the above deaths. It cannot be emphasized too strongly that *a Group IV donor should not be looked upon as a universal donor.* It is unjustifiable to proceed with a transfusion, however urgent, without first performing an individual compatibility test.

Pemberton thus describes the phenomena he has observed in cases of incompatible transfusion : —

" The clinical picture of these reactions is typical. They occur early, **after** the introduction of 50 or 100 c.c. of the blood : the patient first complains of tingling pains shooting over the body, a fullness in the head, an oppressive feeling about the precordium, and, later, excruciating pain localized in the lumbar region. Slowly but perceptibly the face becomes suffused a dark red to a cyanotic hue : respirations become somewhat laboured, and the pulse-rate, at first slow, suddenly drops as many as 20 or 30 beats a minute. The patient may lose consciousness for a few minutes. In one half of our cases an urticarial eruption, generalized over the body, or limited to the face, appeared with these symptoms. Later the pulse may become very rapid or thready : the skin becomes cold and clammy, and the patient's condition is indeed grave. In from fifteen minutes to an hour a chill occurs, followed by a high fever, a temperature of 103 to 105 , and the patient may become delirious. Jaundice may occur later. The macroscopic appearance of hæmoglobinuria is almost constant."

Kidney Disease.— The second warning is to refrain from transfusing patients known to have damaged kidneys. If, for instance, the potential recipient suffers from nephritis, toxæmia of pregnancy, prostatic obstruction with back-pressure, or blackwater fever with albuminuria, blood transfusion is more likely to terminate than to save life. To stipulate that the urine should be tested before every transfusion is not asking the impossible.

Acidosis.— Patients with acidosis are liable to have ' reactions ' after a blood transfusion. Ideally the recipient's urine should be alkaline at the time he receives the blood. In not very urgent cases this can be accomplished by giving suitable doses of potassium citrate. In more urgent cases, where the urine is highly acid, temporary alkalinization can be accomplished by injecting 2 per cent sodium bicarbonate intravenously.

When a patient receives incompatible blood into his circulation, death sometimes follows rapidly from an anaphylactic phenomenon (p. 684). More usually the varying degrees of untoward symptoms, culminating in extreme instances in a fatal issue, are due to anuria. Histologically the renal tubules have been found blocked with precipitated blood-pigments. In these circumstances it will be appreciated how much more readily previously damaged kidneys are overwhelmed.

The treatment follows exactly that of anuria from other causes (*see* p. 330), and decapsulation of the kidneys has been put forward as a possible life-saving measure.

These dangers, with which may be coupled the entry of air into the vein and the possibility of transmitting syphilis, are infinitesimal when reasonable care and precautions have been taken.

COMPATIBILITY TESTS

The Indirect Method. It is necessary to have tubes of stock serum of Groups II and III. The serum must not be more than three months old. Stock sera can be procured from the Lister Institute and from leading firms who put up sera and vaccines. A white tile or a tea-plate is taken and on this is written II and III. Under II is placed one drop of stock serum II. Under III is placed one drop of stock serum III. The potential recipient's ear is sterilized with ether and pricked with a sterile needle. A drop of blood is squeezed out, and with a glass rod a little of it is transferred and mixed intimately with the drop of stock serum II. The amount of blood should be quite small, sufficient to impart a definite red tint, but not enough to colour the serum deeply, an effect which might interfere with the observation of the reaction. The glass rod is washed and dried, and a little more blood from the lobule of the ear is transferred and mixed with the drop of stock serum III. The tile is then gently rocked so as to impart a little movement to the drops. They are examined in a strong light. Agglutination can be seen against a white background with the naked eye. If agglutination occurs within one minute of mixing, the redness within the drop becomes patchy and may be likened to brick-dust. If there is no agglutination at the end of five minutes, it can be assumed that the test is negative. At the end of five minutes, therefore, we note the reaction in the two drops and compare the result with *Fig.* 10, by the aid of which the group to which the recipient belongs can be found. Exactly the same procedure is adopted in ascertaining the group to which the donor belongs. If possible a donor of the same group as the recipient should be procured. If it is decided to utilize a Group IV donor, the test described below should be applied in addition.

The Direct Method is extremely useful for the isolated worker

who has not immediate access to the stock sera.   I have used it alone
in urgent cases on several occasions, and each time have carried out
a successful transfusion.   A hypodermic syringeful of blood is collected
from a vein of the potential recipient and the blood is evacuated into
a test-tube.   It is allowed to clot.   When firm clotting has taken
place a little of the residual clear serum is removed with a pipette.
One drop of this is placed upon a white tile.   The prospective donor's
ear is sterilized and pricked, and with a glass rod a small portion
of blood is transferred to the centre of the drop on the slide.   After
mixing and rocking gently for five minutes, the drop is examined in
a strong light with the naked eye.   If no agglutination occurs, the
prospective donor's blood is compatible with that of the patient.

STOCK SERUM II	STOCK SERUM III	BLOOD
		Belongs to
		GROUP I
Agglutination	Agglutination	
		GROUP II
No agglutination	Agglutination	
		GROUP III
Agglutination	No agglutination	
		GROUP IV
No agglutination	No agglutination	

Fig. 10.—Chart showing method of identifying the different blood-groups.
(*Wood and Ross.*)

If there is any doubt as to whether agglutination has occurred or not, observation of the drop with a magnifying glass or under the low-power objective of a microscope will settle the matter.

Preparation of Citrate Solution.* Citrate solution must be made up freshly for each transfusion. Messrs. May & Baker put up sterilized sodium citrate powder in phials of 1 grm. (*Fig.* 11). These phials may be kept indefinitely until required, and save much time and anxiety. Two grammes of sodium citrate are shaken into the sterile collecting flask. To this 100 c.c. of warm sterile water is added. The salt readily dissolves in the water, and we have in our flask sufficient anti-coagulant fluid for at least one pint of blood, which is the amount usually transfused. A pint is equal to 567·9 c.c. The contents of a third phial of solid citrate are shaken into a sterile measuring-glass and 50 c.c. of sterile water are added. This latter solution is used to syringe through the apparatus, as will be described presently.
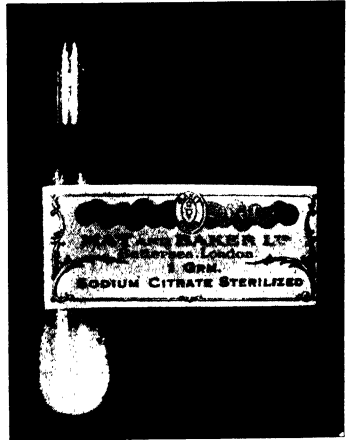
Fig. 11.—A phial containing 1 grm. of sterile sodium citrate.

Apparatus for Collecting the Blood.—A hollow needle with a wide bore (*Fig.* 12) is examined. If the point is not sharp it is touched up upon a hone. To the base of the needle eight inches of soft rubber tubing is affixed. The needle and the tube are wrapped in a piece of gauze and sterilized by boiling. It is advisable to be provided with two such needles and tubing. Immediately before
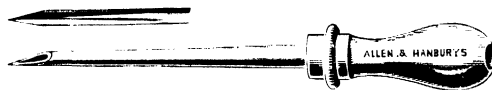
Fig. 12.—French's bayonet-ended tapering blood collecting needle.

use the citrate solution is forced through the tube from a syringe and a hæmostat is applied to the end of the tube. This is not removed until the needle is within the vein, and it ensures the interior of the needle and the tube being moist with an anti-coagulant. A sterile flask or jar with a capacity of at least a pint, and a sterile bowl, are essential also.

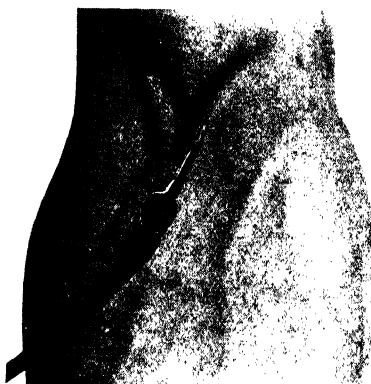*Lewisohn devised the citrate method in 1915, thus conferring a great benefit on humanity.

Collecting Blood from the Donor. It is neither justifiable, nor is it necessary, to cut down upon a vein of a member of a transfusion service; indeed, this is contrary to the rules of these associations. When the donor is a relative or friend of the patient and the veins are relatively inconspicuous, an exception may be made. In such circumstances a vein at the elbow may be exposed and a cannula tied in after the manner shown in *Fig.* 4. In this way a pint of blood is collected quickly.

A Standard Method of Collecting Blood.—Examine the fold at the elbow on both sides, and choose the side with the most prominent vein. If the veins are comparatively small, get the donor to hold his arm in a jug of hot water for five or ten minutes with the water as hot as can be borne comfortably. This is an effective method of producing vasodilatation.

The donor takes off his shirt and lies upon the table, allowing his arm to hang down. The cuff of a sphygmomanometer is placed around the arm as high up as possible; unless the shirt has been removed the rolled-up sleeve gets in the way. *The cuff of the sphygmomanometer is inflated until a pressure of 40 mm. of Hg is registered.* An assistant is detailed to watch the dial of the instrument and to maintain a constant pressure of 40. At this pressure veins are occluded, but the arterial supply is unimpaired.

The arm rests upon a side table, and while final arrangements for collecting blood are being made, the donor slowly opens and closes his hand. The skin about the antecubital fossa is sterilized with alcohol. A pad in the form of a folded towel is placed behind the elbow in order to extend the joint fully. The surrounding area is draped with sterile towels. The operator sits down. The patient is told to stop opening and closing the hand and to keep the arm steady. We are ready for the puncture.

Fig. 13.—Collecting the blood. The needle *in situ*.

One drop of local anæsthetic is injected with a hypodermic syringe into the skin over the vein. The wheal produced is massaged gently with a gauze swab. As soon as the vein is again clearly apparent a tiny incision is made in the skin with the point of a sharp scalpel. The skin over the vein is rendered taut and the needle is thrust steadily into the lumen of the vein (*Fig.* 13). At the time of the puncture the needle and its attached tube is full of citrate

solution. As soon as blood is seen to flow, the free end of the tube is placed in the collecting flask. The operator plants his feet upon a stool, and a bowl containing hot water is laid upon his knees. In the hot water the collecting flask is placed, and the blood drips or steadily flows into the flask and the citrate solution contained therein (*Fig. 14*). Every now and then the flask is rocked gently in order that the blood and citrate solution may be mixed intimately.

blood. The process in operation.

Should the flow of blood lessen, the donor is asked again to open and close his hand. If everything is in order, these muscular contractions speed the flow of blood. It should be unnecessary to add that during the whole of the operation the surgeon is steadying the needle. If these details are adhered to strictly, there is seldom any difficulty in collecting a pint of blood in a short time.

As soon as the desired quantity of blood has been obtained, the

sphygmomanometer is deflated and the hollow needle removed from
the arm, which is dressed and bandaged.   The blood which has been
collected is poured through a filter of two layers of sterile gauze into

Transfusing a young child via the internal saphenous vein.

a sterile jug.   The jug is stood in a bowl of hot water until it is
required.

   Difficulties. – The flow of blood becomes feeble or stops.   Providing
the donor is still in good condition this signifies a mechanical stop-
page.   Ascertain that the sphygmomanometer is functioning and is
registering a pressure of 40.   Very cautiously withdraw the needle a
fraction of an inch or so and if necessary alter the angle at which it
enters the vein.   If this does not produce the desired result, push
the needle in a little further.   When all these expedients have failed,
it is probable that clotting has occurred in the needle or the tube.

Some citrate solution may be injected up the tube, but this seldom rectifies matters. There remains only one course to pursue. Remove the needle and tube. Take the spare needle and tube, and, using the same technique as before, puncture another vein, preferably, but not essentially, in the other arm.

After-care of the Donor. It is remarkable how little a healthy individual is affected by the loss of a pint of blood. He should not, however, immediately resume the upright position. He is conveyed on a stretcher to a bed or couch and there lies quietly for at least an hour. He may be given a hot drink, or, if he prefers it, some alcohol. He should not be allowed to find his own way home, but must be conveyed thither in a vehicle. He should report on the following day for inspection of the arm.

Administering the Blood to the Recipient.—

Conveying the Collected Blood to the Recipient. It is unnecessary and often harmful to move the recipient—the blood should be brought to him. It is feasible to convey the blood to the recipient at a distance. A sample of his blood having been sent fifty miles for compatibility tests, I have conveyed the collected blood to the recipient, keeping it warm on the journey with hot-water bottles.

Administration of the Blood. The simplest and I believe the best method of administering the blood to the recipient is to allow it to gravitate through a funnel and tube precisely in the same manner as a massive intravenous saline is given (p. 2). Commence by running a little saline into the vein and then add the citrated blood. The rate of administration should be slow, and can be controlled by the height at which the funnel is held.

Transfusion in Infancy. In a small child the veins at the elbow are usually too small for a satisfactory transfusion. It is better to make a transverse incision over the internal saphenous vein as it passes anterior to the internal malleolus (*Fig.* 15). Children in need of transfusion are so prostrated that no difficulty is experienced in operating under local anæsthesia.

Dosage of Blood in Infancy. Give 15 c.c. of blood per pound of body weight.

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CHAPTER III

ANÆSTHESIA FOR URGENT OPERATIONS

THE anæsthetic is a matter upon which much thought and care should be bestowed, for it is hardly less important than the operation itself. To have the services of a skilled anæsthetist lightens the surgeon's burden, but often such services are not available in urgent cases. My own feeling is that a local anæsthetic when it can be used is the best of all; it is by developing this form of anæsthesia that we can look to a reduction in mortality figures.

LOCAL ANÆSTHESIA

When local anæsthesia is indicated especially, detailed instructions for infiltrating the tissues are given in the text of this work. One per cent novocain is the solution I favour. Ampoules of sterile novocain are obtainable: all that is necessary is to tip the contents of
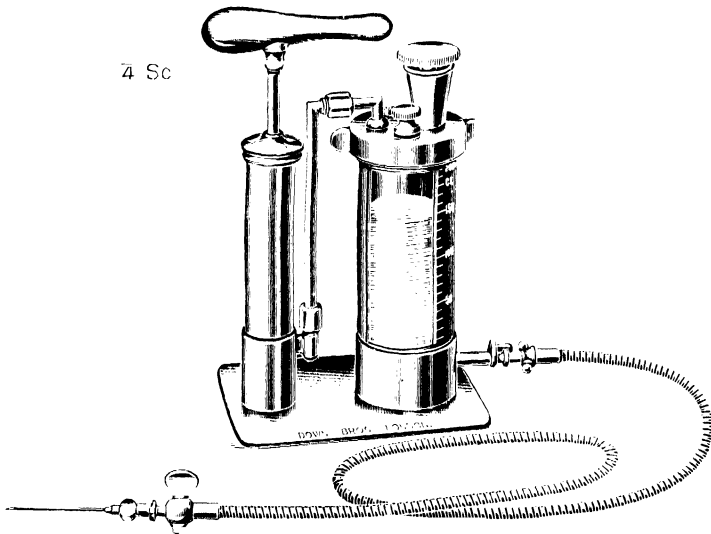
Fig. 16.—Local-anæsthetic pump.

an ampoule into ¼ pint of sterile water and stir. The crystals dissolve at once and the 1 per cent solution is ready for injection. When large areas are to be infiltrated, my pump (*Fig.* 16) for delivering the local anæsthetic saves time and trouble.

Preliminary Sedatives. I employ hyoscine compound (Burroughs Wellcome) as described in connection with spinal anæsthesia (*see below*). When local anæsthesia is to be used, efficient preliminary medication is one of the secrets of success.

SPINAL ANÆSTHESIA

Spinal anæsthesia is useful particularly in cases of acute intestinal obstruction when a lower laparotomy is needed. It can also be employed in cases of acute appendicitis, pelvic peritonitis, and strangulated inguinal and femoral herniæ. Spinal anæsthesia is satisfactory for many of the urgent operations upon the lower extremity. It is, however, in acute intestinal obstruction that its zenith of usefulness is reached. The picture of an unhappy surgeon engaged in a sisyphean task of approximating the peritoneum over a sea of distended and unruly intestinal coils has, by virtue of intrathecal anæsthesia, passed, and given place to quiet and orderly suture of the abdominal wall. Few can deny that spinal anæsthesia has, in a large measure, helped to improve the results of treatment of intestinal obstruction.

An American hospital nurse, aged 36, was admitted with acute intestinal obstruction of five days' duration. She had been fæcal vomiting, and, whilst being examined, brought up two kidney-dishes full of brown, fæcal-smelling fluid. Her pulse was poor and her extremities cold. She refused to have her stomach washed out. Morphia, gr. ¼, and a saline infusion were administered. Twenty minutes later spinal anæsthesia was induced. During the operation (compound adhesions of small intestine and mesentery) fæcal fluid was regurgitated intermittently in small quantities. She recovered.

There are many varieties of spinal anæsthetics. Some appear to be more dangerous than others. All are open to two main objections : (1) Occasionally, true it is only occasionally, they fail to act even when there is no question that the technique of administration has been perfect : (2) In a small proportion of cases symptoms of collapse develop. By proper attention to detail the number of cases presenting these symptoms can be reduced considerably. Personally, I now make it a rule never to attempt spinal anæsthesia for operations above the umbilicus. I have laboured in this field for a good many years, and have tried all, or nearly all, the various preparations. I have come to the conclusion the safest and best spinal anæsthetic is neocaine, and induction of spinal anæsthesia with this substance will be described. The instructions which follow apply to adults only. The only condition in which I use spinal anæsthesia in children is intussusception, and special instructions will be given in that chapter.

Preliminary Medication. Hyoscine compound (Burroughs Wellcome) is the preliminary narcotic which I order. Compound B contains

morphia $\frac{1}{4}$ gr., hyoscine $\frac{1}{100}$ gr., and atropine $\frac{1}{120}$ gr. and it is this dosage which is given unless the patient is frail, when Compound A. which contains morphia $\frac{1}{6}$ gr., and a correspondingly smaller dose of the other substances, is substituted. If possible, the preliminary narcotic should be given forty minutes before the operation. The patient comes to the theatre with his eyes securely blindfolded and with plugs of cotton wool in his ears.
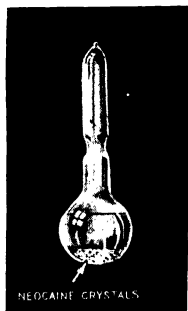

NEOCAINE CRYSTALS

Neocaine is a French preparation, and is supplied by the Anglo-French Drug Co. It is put up in ampoules containing 0·1 grm. of the anaesthetic in crystalline form (*Fig.* 17). The crystals are dissolved in the patient's cerebrospinal fluid and then injected into the theca.

Fig. 17.—Ampoule of neocaine.

Labat's cardiac stimulant is also supplied in ampoules by the same firm.

Inducing Spinal Anaesthesia with Neocaine.—

Everything which is going to be used for the introduction of the spinal anaesthetic is placed in readiness on a small table covered by a sterile towel (*Fig.* 18). There should be : (1) a hypodermic syringe with needle charged with local anaesthetic for the skin ; (2) a

Fig. 18.— Apparatus for neocaine spinal anaesthesia. A, Hypodermic syringe loaded with novocain for infiltrating the skin (not illustrated) ; B, A good pattern of lumbar puncture needle ; C, Barker's needle used when a dry puncture has been obtained by B ; D, A 10-c.c. syringe ; E, An ampoule of neocaine ; F, File for excising neck of ampoule.
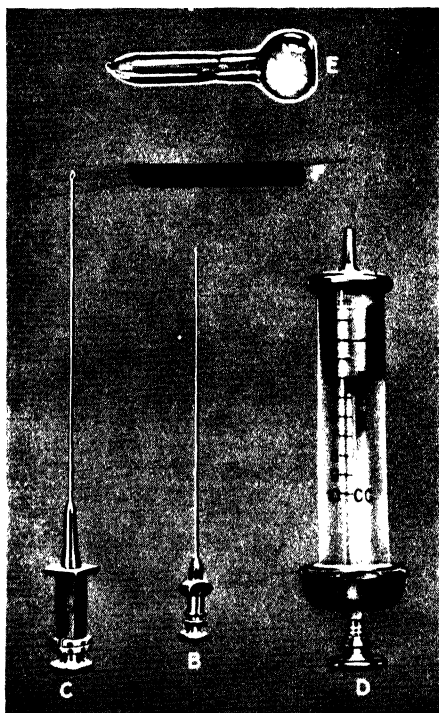
larger syringe ; (3) two lumbar puncture needles. The lateral position of the patient is adopted for spinal puncture ; this position is maintained by an assistant on the left-hand side of the table.

By passing one arm around the patient's neck and the other under his knees the assistant can steady the patient and maintain flexion of the vertebral column (*Fig.* 19). The operator will find it convenient to be seated. The back is sterilized and the towels arranged. See that the back is flexed well and parallel to the side of the table. A small sandbag between the lower ribs and the pelvis is sometimes helpful. Run a finger down the lumbar spinous processes, and having selected the space in which the puncture is to be made (this will usually be between the 3rd and 4th, or 2nd and 3rd lumbar vertebræ), introduce a few drops of local anæsthetic into the overlying skin. Massage away the wheal thus formed with a gauze swab, and again being certain that the back is flexed maximally we are in readiness for the puncture.

Place the thumb-nail over the inferior edge of the spinous process of the vertebra above, and using the thumb-nail as a guide, push the lumbar-puncture needle steadily forwards and slightly upwards into the space. If the puncture is dry do not persevere too long and wear out the patient; three dry punctures should be the signal to desist and procure anæsthesia by some other means. However expert you consider yourself at lumbar puncture, cases will be encountered in urgent surgery in which the needle fails to enter the

Fig. 19.   Patient ready for lumbar puncture. The assistant helps to maintain flexion by placing his right arm around the back of the patient's neck and his left under the patient's knees.

theca. A frequent cause of failure is osteo-arthritis of the spine, which prevents proper flexion.

When the puncture is successful collect the cerebrospinal fluid in the ampoule containing neocaine crystals (*Fig.* 20). The cerebro-spinal fluid should be allowed to run until the ampoule is nearly full, when the stilette is replaced and the flask is removed to the small table. With the aid of the spare needle the contents of the flask are stirred until the crystals have been dissolved. The resulting solution is drawn up into the large syringe. The stilette having been removed, the patient's cerebrospinal fluid in which the neocaine crystals have been dissolved is injected slowly into the theca. The lumbar puncture

needle is then withdrawn and the puncture wound sealed with collodion. At this juncture the nurse injects into the buttock the contents of an
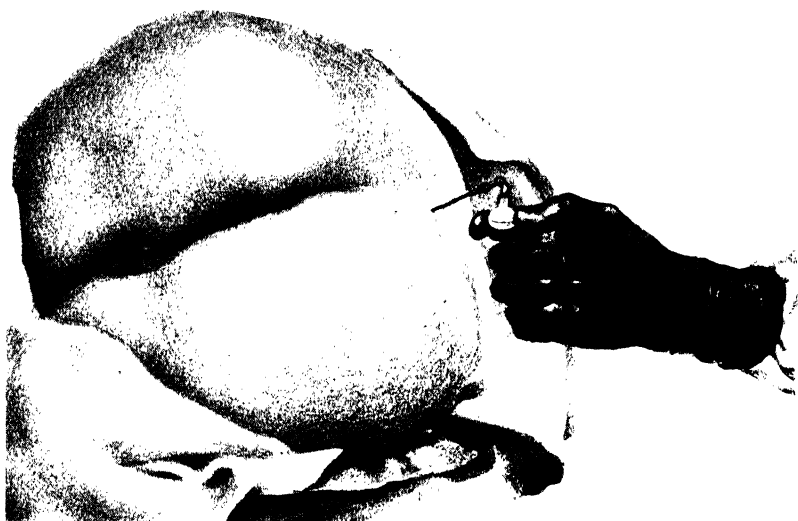
Fig. 20.—Collecting cerebrospinal fluid in the ampoule containing the neocaine crystals.

ampoule of Labat's cardiac stimulant. The patient is now rolled upon his back, and in so doing one places one of the sterile towels so that it comes in contact with the puncture.
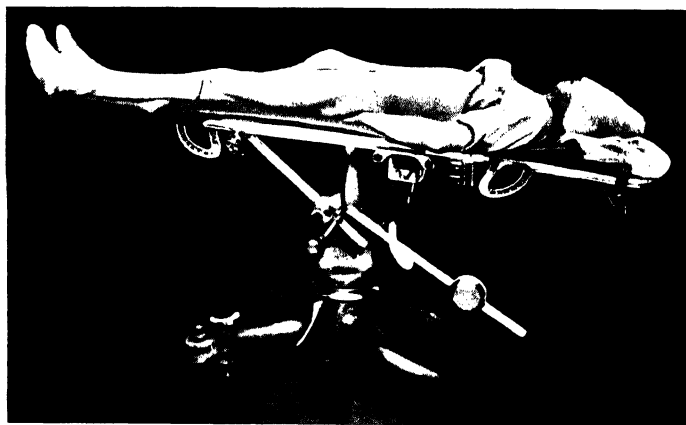
Fig. 21.—Correct position after neocaine has been injected. The table is tilted 15° downwards by the head, the eyes are blindfolded, and the ears stuffed with cotton wool. Note the shoulder-pieces in position, which allow the table to be still further tilted should the blood-pressure fall.

The shoulder-pieces fitted to the operating table used for maintaining Trendelenburg's position are adjusted, and the whole table is tilted 15 by the head. A small pillow is placed under the patient's occiput (*Fig.* 21). If an anæsthetist is present, the case is given into his charge. If only semi-skilled assistance is at hand, I ask a nurse to sit at the head of the table and call out the pulse-rate loudly every two minutes. This ensures that the patient is being watched carefully. The surgeon now scrubs up, and prepares himself for the operation, whilst those in attendance sterilize the operating field.

Is the area of operation anæsthetic? This point is ascertained by pinching up the skin with a towel clip and watching the patient's face. If the face becomes screwed up with pain, it is useless to proceed without supplementing the anæsthetic.

COLLAPSE UNDER SPINAL ANÆSTHETIC (NEOCAINE).–

Golden Rules for Prevention.–

1. Take the blood-pressure before commencing, and never give neocaine to a patient with a blood-pressure under 105 mm. Hg.

2. Always give an intramuscular injection of Labat's cardiac stimulant as soon as the neocaine has been administered, to counteract fall in blood-pressure, and keep a second dose by in case of emergency.

3. In feeble, frail, and under-weight patients do not give the contents of the whole ampoule. Less than two-thirds of the ampoule is likely to be ineffective in even a frail old lady. Judgement must be exercised as to how much of the last third must be given.

There are two 'danger periods' in spinal anæsthesia. The first is almost directly after the injection, and the second is fifteen to twenty minutes later. The danger lies in a fall of blood-pressure, and can be shown by the sphygmomanometer. If the signs of collapse are marked, tilt the table further by the head, for probably the blood is gravitating into the paralysed arterioles in the anæsthetized area. This postural correction of blood-pressure is usually effective, and should be combined with a second dose of a pressor substance, preferably a second dose of Labat's cardiac stimulant.

I have had two dramatic instances of the effectiveness of postural treatment in collapse, and they both occurred when I was using stovaine.

Collapse during the First Danger Period.

A female, aged 56, had a strangulated femoral hernia of some forty-eight hours' duration. After the stovaine had been injected and the operation was about to commence, she suddenly collapsed. The table was lowered by the head, caffeine and pituitary extract were injected subcutaneously, and artificial respiration and precordial packs applied. At the end of ten minutes the pulse could not be felt. She was therefore returned to bed as quickly as possible. The foot of the bed was raised on

a bed table so that it was three feet higher than the head. A funnel and tube were at hand, and the tube was placed in the rectum and about two pints of hot saline poured in. The patient almost immediately began to talk, and a quarter of an hour later had so much improved that again she was taken to the theatre and, whilst in a semi-Trendelenburg position, the operation was performed without any further anæsthesia. The patient made an uneventful recovery.

Collapse During the Second Danger Period. —

J. C., a weak old man of 68, had a strangulated left inguinal hernia of four days' duration. He had been vomiting for three days, and the vomitus was frankly fæcal. Anæsthesia was induced with stovaine, 0·6 c.c. being used. The sac was opened and an imprisoned coil of small intestine released. The hernia was found to be a hernia *en glissade*, the posterior wall being composed of pelvic colon. It was treated in the way described in Chapter XIX. As the last stitches were being placed, the patient collapsed. The table was tilted by the head and pituitrin injected. He was pulseless and moribund. The respirations were of Cheyne-Stokes character. He was hurriedly placed upon the stretcher, the lower end of which was held up so as to maintain the posture. By this time he appeared to be dead, although on the way back to the ward he gave one gasping respiration. Returned to bed, the feet of the bedstead were placed on chairs. Rectal saline was poured in, and cardiac stimulants administered. Two hours later the pulse was good. He recovered.

EVIPAN ANÆSTHESTIA

Evipan sodium is a barbituric acid preparation which decomposes rapidly in the body. The general anæsthesia it induces is brief, and if administered correctly is almost free from danger. Evipan has a large field of usefulness in urgent surgery. It is a very good anæsthetic for short operations, such as opening abscesses and reducing dislocations. It is invaluable for use in the treatment of Ludwig's angina and any infective conditions about the mouth and neck requiring operative intervention.

Contra-indications. —

Defective Liver Function. —Evipan is metabolized in the liver; consequently gross hepatic disease, and particularly the presence of jaundice, is an absolute contra-indication.

Kidney Disease. — If the kidneys are acting but feebly, such as might be the case in advanced retention of urine, this form of anæsthesia is better avoided.

Low Blood-pressure. — As this drug still further lowers blood-pressure to some degree, it should be avoided in such cases.

Antidote.—The best antidote to barbiturate overdose is intravenous injections of strychnine. (Monod.)

### Technique of Administration. —

Evipan is supplied in powder form in ampoules, to which the distilled water supplied in another ampoule is added. By aspirating

and re-injecting once or twice a solution is obtained which passes through a hypodermic needle. This is inserted into a suitable vein of the arm, with due aseptic precautions (*Fig.* 22). It is advisable to have the arm held by a second person because of the twitching of muscle which often comes on soon after the injection has begun. The best plan is to employ Dickson Wright's splint (*Fig.* 23), which greatly facilitates a smooth intravenous injection. *The solution is injected at the rate of* 1 *c.c. in fifteen seconds.* Dosage is determined by the characteristics of the patient and the results noted. A good plan is to ask the patient to count. When the counting ceases through sleep the amount that has been injected is noted and the same amount is further added for a short operation, and twice as much for a longer one. An average amount to produce unconsciousness is about 3 c.c.
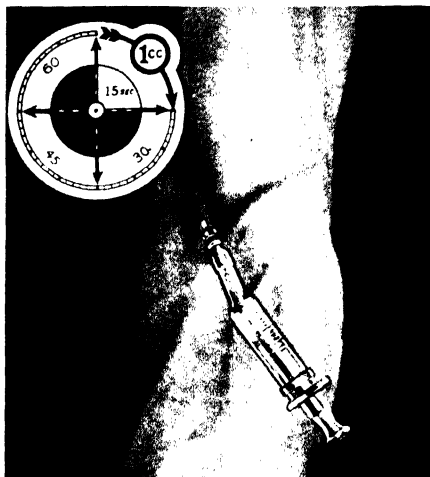
Fig. 22. Injecting evipansodium. The first of 3 or 4 c.c. is injected at the rate of 1 c.c. per fifteen seconds. The remainder of the appropriate dose can be injected somewhat more quickly.

A deep yawn just before the disappearance of conciousness is often observed. The majority of patients fall asleep quietly. Just about this time the jaw tends to drop; it must be held forward so that a satisfactory airway is maintained. Twitchings of the face muscles
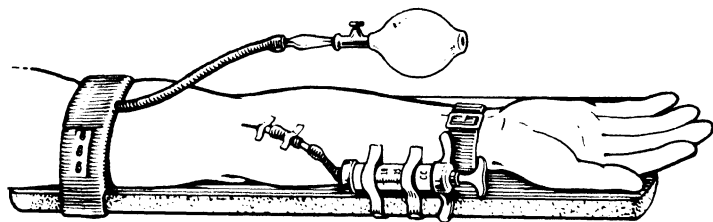
Fig. 23. Dickson Wright's splint for use in evipan anæsthesia and other intravenous injections.

and jactitation of the limbs are quite common. These usually disappear in a few seconds; the patient then remains quiescent with normal pulse and respirations. Muscular relaxation is poor. Evipan is unsuitable for operations which are likely to last more than fifteen

minutes. Everything must be absolutely in readiness for the operation before the injection is commenced.

Evipan and Premedication.—No premedication is necessary or desirable for short operations lasting, say, for ten minutes. When longer operations are contemplated —particularly in the case of abdominal operations Jarman and Abel recommend premedication in the form of a Hoffman la Roche preparation containing omnopon, gr. $\frac{3}{5}$, and scopolamine, gr. $\frac{1}{150}$, one hour before the operation, for all patients between 16 and 70. In a large experience they have found that the premedication adds to the smoothness of evipan anæsthesia and promotes muscular relaxation. On no account should nembutal, or other barbiturates, be ordered when evipan is used.

INHALATION ANÆSTHESIA

The relative merits of the various inhalation anæsthetics will not be discussed here. They belong properly to the domain of the anæsthetist. Before leaving the subject we must discuss fully one of the most urgent of the surgical emergencies.

IMPENDING DEATH UNDER GENERAL ANÆSTHESIA

In order to deal with the situation as efficiently as possible it is necessary to have a preconceived plan upon which efforts to resuscitate the patient may be based. I have often reflected how profitable it would be to have organized drill to prepare us for these cases. Desirable as this would be, with a staff constantly changing it is not always practicable. We can, and should, however, be provided with a cardiac emergency outfit (*Fig.* 24). This is an oblong glass jar containing the following : (1) A bottle of adrenalin solution, which should be changed once a month to ensure potency ; (2) Some phials of alpha-lobelin ($\frac{1}{6}$ gr.); (3) A Record syringe and hypodermic needles ; (4) Cardiac puncture needles $3\frac{1}{4}$ in. long. This jar is kept sealed, and bears a label— CONTENTS ONLY TO BE USED IN CASE OF EMERGENCY.

Impending death under anæsthesia ranks, after severe arterial hæmorrhage, as the most urgent of all emergencies.

Management.—It is assumed that the anæsthetist has pulled the tongue forward, and has cleared the airway.

The Time Factor. It is probable that certain cases are abandoned as hopeless prematurely, owing to anxiety masking our estimation of time. Minutes under these circumstances hang fire, and if the clock is not watched, it seems that the customary twenty minutes of endeavour have passed when perhaps not more than half of that time

has elapsed. In order to organize the theatre team to the best
advantage, a student or a nurse should be detailed to cry each passing
minute.

Posture.—Get the head low by tilting the operating table, or by
raising the foot of the bed. " It is obvious that the cortex can be
kept from death for hours by the merest trickle of blood " (Leonard
Hill).

Artificial Respiration.—On receiving a request from the anæs-
thetist for artificial respiration, the usual practice is for the operator
to exert rhythmical pressure on the lower thorax. Useful as this
method is, I do not believe it should be carried on for more than
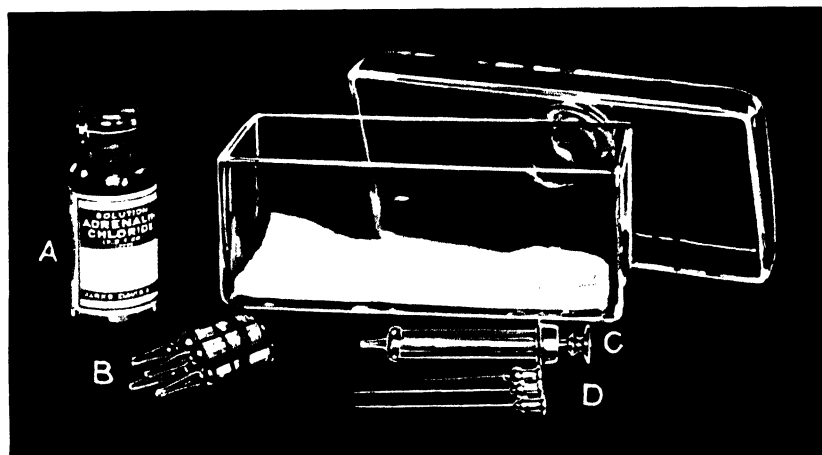

Fig. 24.—Cardiac emergency outfit. This should be kept sealed in readiness
for an emergency in the operating theatre. **A,** Adrenalin solution; **B,** Phials of
alpha-lobelin, ¹⁄₂ gr.; **C** and **D,** Syringe with hypodermic and cardiac puncture

one or two minutes. If after this period respiration has not recom-
menced, the field of operation should be covered with a sterile towel
clipped securely to the skin. One arm is grasped by the surgeon,
the other by an assistant, and Sylvester's method of artificial respir-
ation is slowly, systematically, and symmetrically carried out.
Alternatively—and probably more effectively—the direct method of
artificial respiration may be employed.

The Direct Method of Artificial Respiration.—The procedure is
simplicity itself. There is no need to intubate the larynx ; the
mouthpiece of an ether inhaler is generally at hand, and when placed
in position on the patient's face makes an admirable funnel through

which the surgeon or the anæsthetist can blow into and inflate the patient's lungs (*Fig. 25*). In the absence of a face-piece, a funnel can be extemporized with the closed hand. There is no resistance to overcome ; the air easily enters and inflates the lungs, and is expelled automatically, or rather gurgles out with the help of gentle pressure on chest or abdomen. *The process is repeated every four or five seconds* until normal rhythmical respirations are restored.

Alpha-lobelin.—The contents of a capsule of alpha-lobelin are injected subcutaneously. Alpha-lobelin is an essential alkaloid of the herb lobelia, and is a specific stimulant of the respiratory centre. It acts in three minutes, and will often restart respiration when other methods have failed. Directly the injection has been made, artificial respiration should continue.

Fig. 25.—The direct method of inflating the lungs. (*After Sir William Wheeler.*)

Stretching the Anal Sphincter.—This is only of use in light anæsthesia, when there is a full, bounding pulse, but the patient, in spite of artificial respiration, 'won't breathe'. It is founded upon experience gained in rectal operations, when stretching the sphincter brings on deep crowing inspirations. It is a method with a limited, but distinct, field of usefulness.

We will now deal with the occasional and very alarming case : artificial respiration has been in progress for upwards of five minutes ; there is no improvement in the situation, in fact the pulse is so poor that it is doubtful if it can be felt.

Precordial Packs.—Whilst artificial respiration is still in progress the theatre sister is preparing a bowl of hot water at about 112° F.

A towel is wrung out and placed over the precordium, and this is changed at frequent intervals during the Sylvester inspiratory movement. I have great faith in the efficacy of precordial packs.

Is the Heart Beating?—The anæsthetist, with a finger upon the carotid, has a better opportunity of answering this question than those performing artificial respiration, who can only detect a pulse at the wrist when it is fairly full. If there is a doubt (after the anæsthetist has adjusted his stethoscope), artificial respiration is discontinued momentarily, and he listens for the heart-sounds.

Injecting Adrenalin into the Heart.—A hypodermic syringe is loaded with 10 min. of the solution by the ward sister in charge of the case. The syringe is fitted to the 3¼-in. (aspirating) needle. The injection should be made within five minutes of ascertaining that the heart has stopped beating. The needle is thrust into the fourth interspace at the upper rim of the fifth rib, close to the sternal border. The needle should be directed backwards and slightly medially (Bodon). The problem of the exact time to make the intracardiac injection is a difficult one. " Under five minutes of being certain that the heart has stopped " is the best rule. I have had one case in which intracardiac adrenalin started the heart beating and the patient recovered.

After the injection, artificial respiration is resorted to once more, but the surgeon should now be changing his gloves in preparation for cardiac massage. One minute after the injection the anæsthetist again listens for heart-sounds. A negative finding is the indication for playing the last card.

Cardiac Massage.—The mid-line epigastric incision is the simplest and most rapid approach. With the right hand in the abdomen and the left on the costal margin, efficient massage can be maintained (*Fig. 26*). The alternative method of grasping the pericardium and intermittently squeezing the ventricles should be reserved for those cases with a rigid costal wall ; when the first method is being practised in elderly subjects, the heart seems to slip out of reach. In order to gain access to the pericardium, all that is necessary is to make an incision on to the costal cartilages from the abdominal aspect. The insertion of the diaphragm is freed over the length of the incision, and the right hand is passed into the thorax and grasps the heart within its pericardium. If the operation has commenced and is an upper abdominal one, not only can cardiac massage be carried out with ease, but the fingers on the left cupola of the diaphragm, detecting the slightest cardiac flutter, enable the operator to answer at once the all-important question, " Is the heart beating? " I have performed cardiac massage in more than a dozen cases. In six cases the heart restarted, but the ultimate results were disappointing

for death occurred within six hours. One case was successful, and another lived fifty hours. In both of these an intracardiac injection of adrenalin was tried first without success.

Fig. 26. Method of performing cardiac massage. (*After* K

The following are notes of a successful case : -

Male, aged 3. Acute intestinal obstruction, due to adhesions around an inflamed appendix   As the operation (appendicectomy and freeing coils of adherent gut) was being concluded, the patient stopped breathing. Artificial respiration three minutes, no improvement. Intracardiac injection of adrenalin, no improvement. The child appeared quite lifeless. Cardiac massage for over a minute. Heart gradually started to beat, at first intermittently. Condition improved. Abdomen closed rapidly, and the patient returned to bed. Recovery. Discharged to convalescent home at the end of the fourth week.

Summary.—The patients who stop breathing and give rise to anxiety whilst under a general anaesthetic may be divided into two main classes, those exhibiting respectively (1) blue asphyxia (primarily respiratory), and (2) white asphyxia (primarily cardiac).

In blue asphyxia there is seldom any need for serious concern. The anaesthetist having cleared the airway, got the tongue forward, and administered oxygen, artificial respiration and an injection of alpha-lobelin usually bring about a restitution. In stubborn cases stretching of the anal sphincter is a useful adjunct.

White asphyxia calls for a calm, organized mass effort on the part of the whole theatre staff. As far as possible each should have a duty. Artificial respiration, precordial hot packs, intracardiac

injection of adrenalin, and cardiac massage is the order in which we play our hand ; but, above all, we should keep on trying until at least twenty full minutes have been cried by the timekeeper.

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CHAPTER IV

ARMAMENTARIUM

" SUPPRESS every manœuvre and every instrument which is not absolutely indispensable." (Doyen.)

A few suggestions only will be put forward on this subject, as the surgeon will use the instruments with which he has become familiar at his teaching school, and will gradually modify these to meet his particular requirements. An endeavour should always be made to use as few instruments as is compatible with efficiency.

Spencer Wells Forceps.— Spencer Wells forceps, for the sake of convenience, will be described as hæmostats in the chapters which
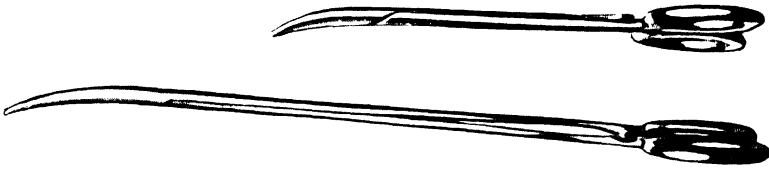
Fig. 27. —Patterns of Spencer Wells forceps used by the author. They w be referred to in the text as long and short hæmostats.

follow. The pattern of the forceps which I prefer has a gentle curve on the flat and a tapering point. The ratchet has four teeth. They are of two sizes (*Fig. 27*).

Fig. 28.—Bracket table for the use of Spencer Wells forceps alone. The short hæmostats are on the near side. The table rests on the patient's legs.
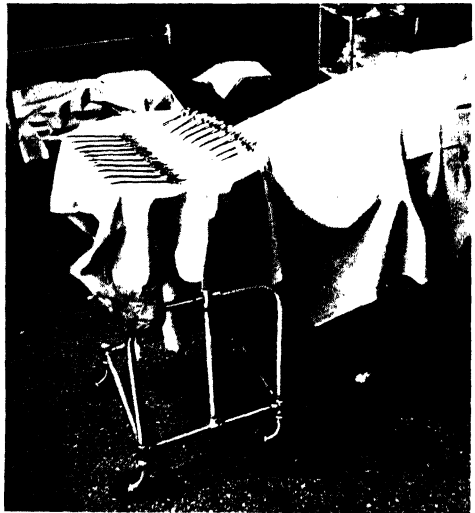
These will later be referred to as the long and short hæmostats.

When operating it is well to avoid an accumulation of instruments on the towels about the wound ; a

disorderly mass of tangled instruments on the towels which cover the
patient's thigh is too often seen. Great help in keeping a clear and
orderly field is to have a little bracket table which is lowered over
the patient's legs when everything is in readiness for the operation
(*Fig.* 28). This table is reserved entirely for Spencer Wells forceps.
On the near side are the short hæmostats and on the far side the long
hæmostats. The surgeon picks them off the table himself. In general
the operation will proceed in a more orderly fashion if bleeding points
are ligatured as they occur. After each bleeding point has been tied
off the assistant should return the hæmostat to the special table, and
should not leave them lying on the towels.

Retractors. --

London Hospital retractors (*Fig.* 29) will be seen in use in
several of the illustrations in this work. These retractors are made

Fig. 29. --Retractor (London Hospital pattern).

in two sizes, large and small. The large ones are unnecessary for
urgent surgery.

Sargent's depressor (*Fig.* 30) is to me an indispensable instrument.
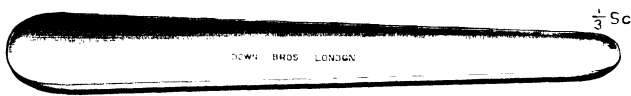
Fig. 30. --Sargent's depressor.

The uses to which it may be put are legion. Many references will be
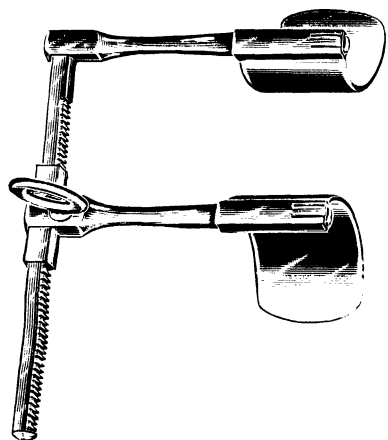made to it in the text.

Wound Hooks (*Fig.* 31). A pair of large wound hooks (**Liverpool**

Fig. 31. Abdominal wound hooks (Liverpool pattern.)

pattern) are very useful, and are referred to at some length in the section dealing with the mid-line upper abdominal incision.

The mechanical retractor shown in *Fig.* 32 has been of great service to me. I have had one in constant

Fig. 32. A universal mechanical retractor (author's pattern). Blades of various sizes are interchangeable. (Genito-Urinary Mfg. Co.)

use for ten years without it needing repairs. It can be used as a rib spreader and is very effective in a lumbar kidney wound, in addition to its duties in the anterior abdominal wall.

Dissecting Forceps. Jeans' pattern (*Fig.* 33) combines strength with delicacy. Of substantial proportions, the large holes help to make the instrument comparatively light to handle.
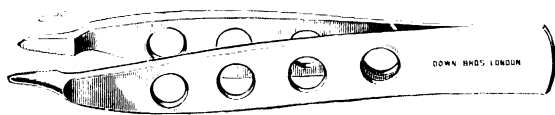
Fig. 33.—Jeans' dissecting forceps.

Walton's Model of Watson Cheyne's Dissector (*Fig.* 34). A handy instrument which can be put to many uses. There is a dissector at one end and a probe at the other. The fluted handle may

Fig. 34. Wal

be passed under a large vein or tendinous structure (as, for example, the inner end of Poupart's ligament in Hey Groves's operation) prior to its ligature or division as the case may be.

Denis Browne's Gland-holding Forceps (*Fig.* 35) are well worth a place in the surgeon's bag; used very lightly without closing the rachet they can be
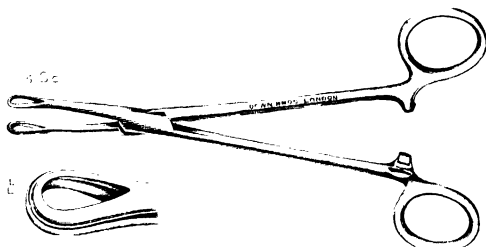
Fig. 35. Denis Browne's gland-holding forceps.

employed to deliver the cæcum. They are excellent lung-holding forceps, and can be adapted for other purposes, e.g., removing gall-stones from the gall-bladder.
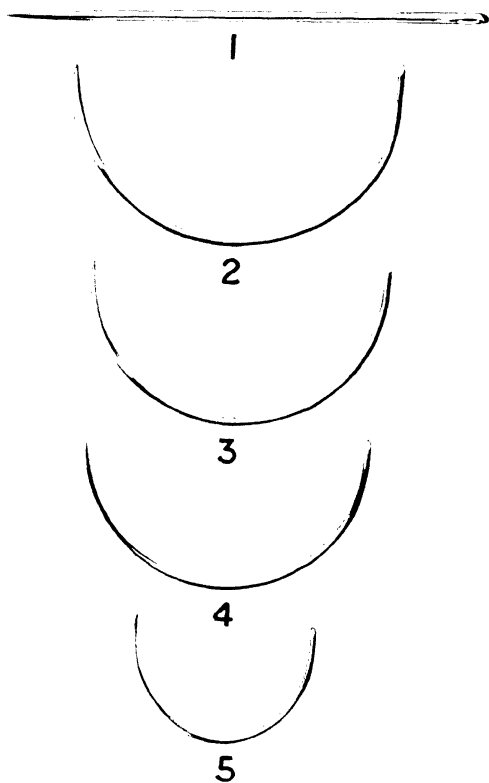
Needles (*Fig.* 36). Here again the surgeon will exercise individual preference. In this work the following needles are used : —

Straight cutting needles (*Fig.* 36, 1), gold-plated, for inserting skin sutures.

Large curved cutting needles (*Fig.* 36, 2), gold-plated. Only used for inserting through-and-through sutures.

Curved round needle (*Fig.* 36, 3) for sewing the peritoneum and inserting 'ligatures on a needle', etc. This is the needle which is used more than any other.

Curved cutting needle (*Fig.* 36, 4) for sewing fascia.

Small round needle (*Fig.* 36, 5). Used with a needle-holder for inserting sutures in inaccessible situations. This is comparatively seldom used.

Souttar's eyeless needle with catgut attached for intestinal sutures. These should always be at hand.

Needles 3, 4, 5 (*Fig.* 36) are malleable. They are bendable, and do not readily break. They are made for me by Messrs. Philip Spencer, of Redditch. In using the curved needle the point is directed towards oneself whilst sewing. It is held in the manner shown in *Fig.* 37.

Method of holding a curve needle.

Needle-puller (*Figs.* 38, 39).—This is a most useful ment. It is a slight modification of Printy's needle-holder. The thumb ring is on the opposite limb and the ring is
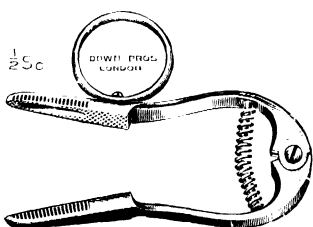
Fig. 38.—Printy's needle-holder, as modified by the author.

somewhat larger than Printy's model. With a little practice the needle-puller may be kept for long periods on the thumb. When the instrument is not in actual use the ring is allowed to slide to the base of the thumb, when the instrument proper can be accommodated in the palm, and is out of the way whilst ligatures are being tied, etc.

Ligatures and Suture Materials.—For all buried sutures and ligatures catgut is used. Nothing thicker than No. 0 or No. 1 catgut is employed. If greater strength is required, two stands of catgut are used together.

For through-and-through stitches stout silkworm gut is used. The skin is brought together with fine interrupted silkworm gut.

Only one type of knot is used throughout this work, and that is the reef knot. It is tied in a plain, straightforward manner, with two hands.

Several special instruments for particular purposes will be described under the appropriate sections.

Sterilization of the Patient's Skin.—The iodine preparation of the skin has stood the test of time, and for urgent cases it is unsurpassed.

CHAPTER V

LAPAROTOMY

EXPLORATORY LAPAROTOMY

" ANYONE who opens the abdomen should be capable of dealing with any condition he may find there." (Sherren.)

A correct diagnosis is the handmaiden of a successful operation. If, on opening the abdomen, we find what we expect, the operation is more likely to proceed smoothly, and on the whole it is bound to be done better. It is not so very long ago that eminent authorities suggested that the important point to be decided was that the case was one of 'acute abdomen', and then to 'explore'. With the accumulated experience of these explorations and the resulting records of symptomatology and corresponding operative findings, the signs and symptoms of acute abdominal disease became better understood and classified. Improvement in this direction is still proceeding. Atypical cases still provide a number of instances where an exploratory operation is the only course. We should, however, always strive our utmost to arrive at a pre-operative diagnosis. In cases of doubt a fundamental principle is to try to decide whether the upper or lower abdomen has to be opened not always an easy matter.

If the abdomen has been opened in an unsuitable place, there are two possible courses to pursue : (1) To prolong the incision into the region of the lesion ; (2) To close the incision and reopen the abdomen elsewhere. Early in my career I came to the conclusion that usually two small incisions are better than one large one, for the following reasons : (a) A large incision is difficult to sew up unless the anaesthesia is perfect and there is no intestinal distension ; (b) With an extended incision infection is liable to be distributed, especially from the lower to the upper abdomen ; (c) Immediate complications attending an incision which becomes infected are proportionate largely to its size.

Throughout the succeeding chapters reference will be made to particular incisions. It will be convenient here to describe a standard method of opening and closing the upper and the lower abdomen.

The Upper Abdomen: The Mid-Line Incision.—The mid-line incision in the *upper abdomen* appears to be the best incision for emergency work (*Fig.* 40). By using this incision the abdomen is opened readily, and, what is more important, it is closed easily. The path

traversed by the incision is practically avascular. Furthermore, the incision can be enlarged quickly. The incidence of post-operative hernia is not greater than that following most incisions.

Midway between the ensiform and the umbilicus, exactly in the middle line, an incision about three inches long is made—it need not be longer, for it can be enlarged upwards or downwards as circumstances demand. Towels are clipped to the skin edges in such a manner as to hide the clip beneath the towel. It is advantageous in the long run not to clip the towels at the extremities of the wound until it is ascertained that the length of the incision is adequate. The

Fig. 40. —A gridiron incision was used to explore the abdomen in this case. On opening the peritoneum blood poured out. The incision was therefore closed and a mid-line upper abdominal one substituted, through which the spleen, which had ruptured spontaneously, was removed.

incision is deepened and the aponeurosis cut through. The aponeurosis is composed of white fibrous tissue, and practically no bleeding occurs. The peritoneum is opened.

Closing the Incision. Wound hooks are placed in the extremities of the incision (*Fig.* 41). These are lifted by the assistant, who will find it convenient to stand on a stool, for traction has to be maintained until the incision is closed. These hooks dispense with the necessity of placing forceps on the edges of the peritoneum. Silkworm-gut sutures are passed at intervals of about three-quarters of an inch on a large cutting needle. These sutures traverse all layers and, having been passed, their free ends are clipped independently in hæmostats. The aponeurosis is approximated by a continuous catgut suture, a moderate-sized curved cutting needle being used for the purpose (*Fig.* 42).
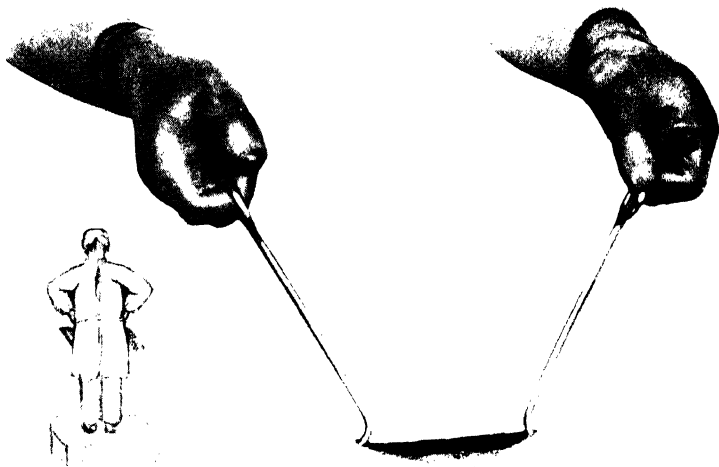
Fig. 41.—Wound hooks in action. The inset shows the assistant
    on a stool, whereby the hooks can be supported with less fatigue.
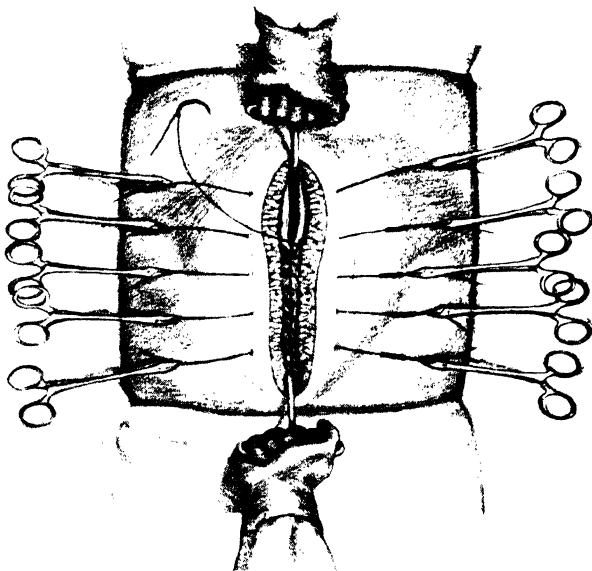
Fig. 42.—Closing the mid-line upper abdominal incision.

After this layer has been closed the through-and-through sutures are tied firmly, but not too tightly (*Fig.* 43). *Not until this stage has been completed are the hooks removed*, nor is the upward tension on them slackened, for without their aid there is a danger of a loop of intestine being ensnared under a deep suture. Once the last deep suture has been tied the hooks are removed. The skin edges are then brought together by fine interrupted sutures between the deep stitches. The through-and-through sutures should be left in thirteen or fourteen days. I have opened and closed the upper abdomen in this manner hundreds of times, and can recommend it unhesitatingly.
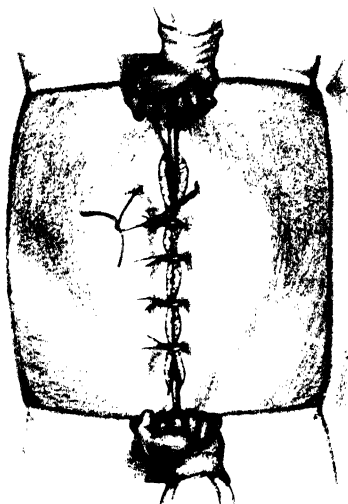
Fig. 43. Closing the mid-line upper abdominal incision. The last through-and-through suture is being tied. The hooks are then removed, and a few skin sutures complete the closure.

The Lower Abdomen: The Paramedian Incision.—The mid-line incision, so efficient in the upper abdomen, cannot be recommended in the lower. A strictly median incision below the umbilicus is very prone to give rise to a post-operative hernia, which is associated with the largest incidence of strangulation; therefore the right paramedian incision is used.

An incision about five inches long and one inch from the middle line is made. Bleeding points are secured. Towels are clipped to the skin edges. The rectus sheath is incised within the limits of the incision. Hæmostats secure the medial cut edge of the sheath. The muscle is dissected out of its bed and retracted laterally *Fig.* 44). The peritoneum is opened.

Closing the Incision.—Long hæmostats grasp the cut edge of the peritoneum. There should be forceps on each extremity and two on each side. The forceps on the extreme upper end should take a large bite of tissue so that the assistant can exert some upward traction in this direction. When difficulty is experienced in approximating the peritoneum in spite of this traction, Sargent's depressor (*see Fig.* 30) is useful in keeping back unruly coils. When great difficulty is encountered in this respect an abdominal pad is introduced and Sargent's depressor applied over this. Commence by sewing up
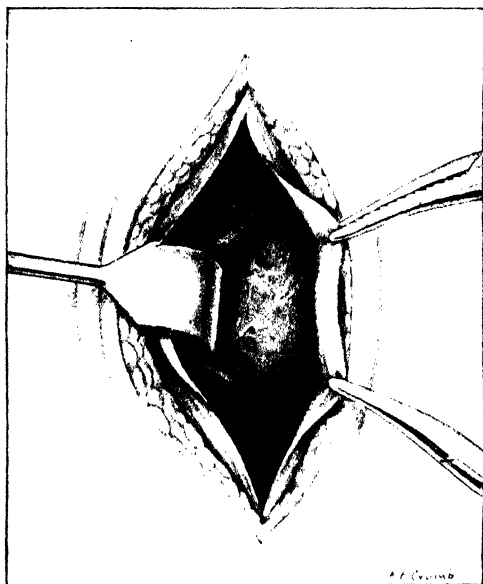
Fig. 44.--The right lower paramedian incision.

the inferior end of the incision. If the peritoneum is holding well, an over-and-over stitch is used. If the stitches tend to cut out, a large bite is taken on the under surface of the peritoneum parallel to its cut surface (*Fig.* 45). The lower part of the incision is usually the most difficult to close. As soon as we have got above the semilunar fold of Douglas the peritoneal layer will nearly always hold its stitches. Having closed the peritoneum, two stout tension sutures are passed through the skin and anterior rectus sheath. These stitches are not tied until the last skin stitch has been inserted. The anterior rectus sheath is now closed. My preference is for interrupted catgut sutures for this layer; I feel that there is some advantage in each stitch being

independent. The skin is sewn up, and finally the tension sutures alluded to are tied, not too tightly.

A Method of Opening the Peritoneum Applicable to all Incisions. — Wounding an underlying structure whilst opening the peritoneum is an error not infrequently committed by the beginner. The following method guards against this possible danger. The peritoneum having been displayed, it is picked up in dissecting forceps and elevated. With a little shake imparted to the instrument any structure lying hard up against the under surface of the peritoneum is likely to be
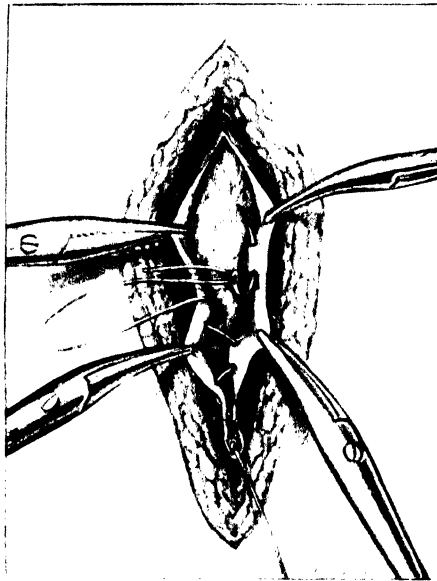
of the peritoneum in cases of difficulty.
under surface parallel to the cut edge

disengaged. A hæmostat is applied to the pinched-up fold. The dissecting forceps are then momentarily removed and the fold is shaken again by the hæmostat. The dissecting forceps once more pick up the elevated peritoneum at a convenient point near the hæmostat, which is handed to an assistant. Holding a scalpel nearly horizontally, the peritoneum is incised (*Fig.* 46).

A Method of Enlarging an Opening into the Peritoneum.—The peritoneum is enlarged in an upward direction with scissors. This is done first. It is then enlarged downwards in the following manner. The first and second fingers are directed downwards beneath

the peritoneum, which is severed deliberately with the scalpel (*Fig.* 47).

The Gridiron Incision. —

Indications.—(1) It is the best incision for the removal of the acutely inflamed appendix ; (2) It is occasionally of value as an avenue of approach in an acute abdominal catastrophe of uncertain origin. If unsuitable, the incision is closed readily. (*See Fig.* 40.)

It is far from our intention that we should be cramped for room. The reverse is the case ; but in the first instance the incision should be small. It can always be enlarged if necessary. Enlargement should be undertaken at the very first sign of difficulty, for
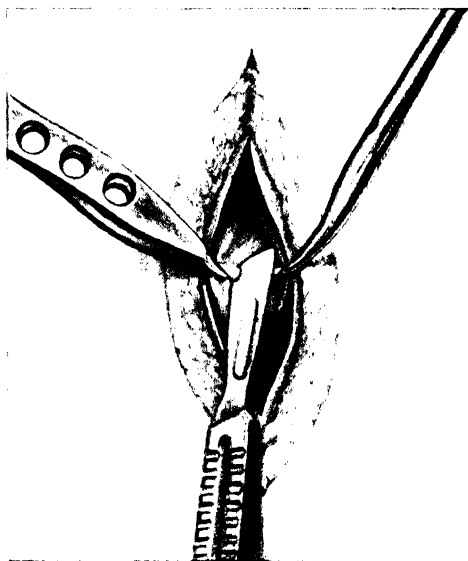
Fig. 46.—A method of opening the peritoneum applicable to a that the scalpel is held practically flat.

the opening must be of sufficient dimensions for the appendix to be removed without dragging and pulling.

The incision is made at right angles to a line joining the anterior superior spine to the umbilicus, rather nearer the former than the latter. The classical site for the incision may be subjected to a certain degree of variation with advantage. Thus, if on palpating the right iliac fossa under the anaesthetic (a step which should never be omitted when this incision is contemplated) the appendix, or omentum which surrounds it, can be felt, the incision is made over the centre of the lump. Again, if the appendix is judged to be
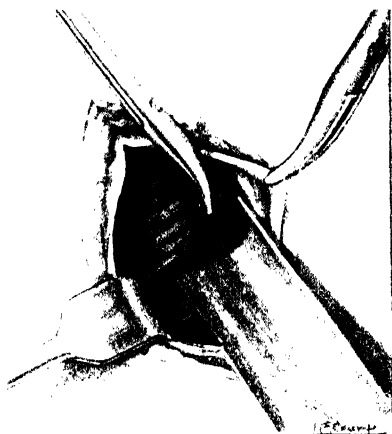
retrocæcal, the incision is made a little higher and a little nearer the flank ; and so on.

The skin having been incised and bleeding points ligatured, towels are clipped to the wound edges. The external oblique aponeurosis and muscle, if any lies within the limits of the incision, are incised in the direction of their fibres. A long hæmostat picks up the medial cut edge, and a curved retractor is placed under the lateral margin. The assistant holds the hæmostat in his left hand and the retractor in his right. The internal oblique is now divided in the direction of its fibres ; the scalpel is held with its blade towards the middle line and the superficial part of the muscle in the outer part of the wound is divided. The remainder of the muscle is split with the handle of the scalpel working in conjunction with the left forefinger. One burrows in this manner through the transversalis also. As soon as the peritoneum is reached, the scalpel is laid aside and the split is made more complete by stretching the wound with the forefingers after the retractors have been removed. A pair of curved retractors are placed under the split transversalis whilst the peritoneum is picked up. The peritoneum is incised in the manner described already (*see Fig.* 46). Once the peritoneum has been nicked the opening is enlarged by stretching it with the handle of the scalpel and the forefinger. This method gives a circular hole which can be encircled with a purse-string suture when the time comes for the incision to be closed. Finally, a good tip is to pass the curved retractor under the peritoneum on the medial side and give the handle to the assistant to hold directly upwards (*see Fig.* 73). Thus the abdominal wall is lifted up whilst the surgeon peers into the wound and

locates the cæcum, and incidentally notes anything else he sees, notably the amount and character of the peritoneal exudate.

Closing the Gridiron Incision.—The edges of the peritoneum are picked up in hæmostats and a purse-string suture is inserted and tied, thereby closing the peritoneum with a minimum amount of catgut. The edges of the split internal oblique are approximated by a single stitch applied in the form of an X. Two interrupted stitches bring together the external oblique aponeurosis, and there remains only the skin to be stitched up. A glove drain under the skin is advisable in all except very early cases of acute appendicitis where the disease is confined to the mucosa.

ENLARGING THE GRIDIRON INCISION.—If one is simply hampered for space in which to deliver the cæcum, the skin and external oblique are divided still further, after which the internal oblique can be split more completely and a limited degree of space is added to the incision.

What is more important is to have at one's command a method of extending the incision in order to trace an anomalous appendix upwards or downwards. More often it is in the upward direction that we have to follow the organ.

*A Method of Gaining more Room in an Upward Direction.*—The skin and external oblique incision may be extended in an upward direction. This is not always necessary, and if it is judged that only a moderate amount of extra room will be required this step is deferred.

Fig. 48.—Enlargement of the gridiron incision. The internal oblique is detached from its insertion into the rectus sheath. A Sargent's depressor is used to protect underlying structures.

The medial cut edge of the external oblique is picked up in a hæmostat and retracted. A little blunt dissection between the external and internal obliques renders the insertion of the internal oblique into the rectus sheath demonstrable. This junction must be seen clearly. The narrow end of a Sargent's depressor, concave surface uppermost, is slipped under the peritoneum, and after peering along its surface in order to make quite certain that no structure intervenes, the internal oblique is severed from the rectus sheath and the underlying peritoneum likewise divided (*Fig.* 48). Usually a vessel

requires attention on the medial aspect ; this is whipped over with a needle carrying a ligature. When using this method it is surprising what a gain in space attends a prolongation of even one inch.

Closing the Extension. -A purse-string, so useful for closing the peritoneum in the case of an ordinary gridiron incision, cannot be recommended when that incision has been extended. The peritoneum should be closed after the manner which is usual in a laparotomy incision. The apex of the ⌐-shaped incision is picked up in a hæmostat, and this corner is sewn on to the rectus sheath opposite the split internal oblique. Interrupted sutures complete the repair, which when finished forms a neat ⌐ (*Fig.* 49). The rest of the incision is closed in the usual manner.
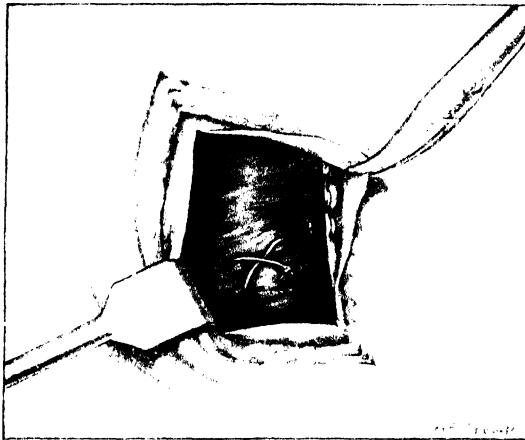
Fig. 49 - The repair of the ⌐ incision When the suturing is completed the ⌐bles a reversed L.

Extension in a Downward Direction.—If more room is required in the downward direction, exactly the same principle is adopted with that part of the internal oblique which lies below the split in its fibres.

I have carried out the ⌐-shaped extension of the gridiron incision in over 250 cases. The incidence of post-operative hernia is almost negligible, and has only occurred in those cases in which prolonged suppuration has ensued. In two of these a secondary operation for the repair of the hernia had to be undertaken, and the reconstitution of the abdominal wall proved to be simple.

Battle's Incision.—

Indications.— (1) Pelvic appendicitis, particularly in women where disease of the adnexa cannot be excluded ; (2) A similar incision to

Battle's incision, only on the left side, is used when perforated diverticulum of the colon is suspected.

An incision about three inches long is made a little to the lateral side of the middle of the right rectus muscle. After towels have been clipped to the wound edges the incision is deepened, and the rectus sheath is opened in the length of the incision. Hæmostats are placed on the lateral cut edge of the sheath and the muscle is mobilized medially. Any bleeding points in the muscle are whipped over with a ligature on a round-bodied needle. The assistant then draws the belly of the muscle to the left. This necessary retraction is performed preferably with the crooked index finger (*Fig.* 50), for metal retractors
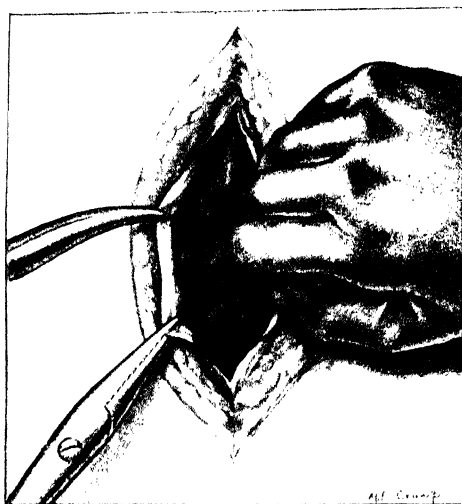
Fig. 50.—Battle's incision. The rectus and the muscle is retracted medially by Metal retractors are liable to injure the de

tend to wound the deep epigastric vein and cause troublesome bleeding. The deep epigastric vessels are rather a bugbear, and certainly constitute a main disadvantage of this incision; if, however, the finger is used as a retractor they usually escape injury. The peritoneum is opened rather nearer the inferior end of the incision, the better to avoid two small nerves in the vessel which pass into the deep surface of the muscle. An endeavour to preserve these nerves should be made; but they must often be divided or break when the intra-abdominal manipulations prove troublesome. I have been unable to satisfy myself that any harm results from the solution of their continuity.

Repair of the Incision. —This is carried out in precisely the same manner as the lower paramedian incision -to wit, the peritoneum is sewn up, through-and-through sutures are placed through the skin and under the rectus sheath (usually one suffices), the rectus sheath is drawn together with interrupted catgut sutures, after which the skin is sewn up.

BURST ABDOMEN

As can be seen in the *Table* of 16 consecutive cases, the abdomen bursts open at varying times between the fifth and the sixteenth day after operation. This accident is liable to occur particularly when the patient has a violent cough. Other factors are straining under the anaesthetic during, or soon after, suture of the abdominal wall; digestion of catgut sutures by ferments, as in acute pancreatitis; or failure of the tissues to heal, as an accompaniment of general debility.

ORIGINAL OPERATE

	Gastro-enterostomy	Paramedian	12	Recovered
	Carcinoma of rectum (inoperable)	Lower paramedian	5	Died (of his disease)
	Carcinoma of stomach		5	Wound healed well
	Gastro-enterostomy	Upper paramedian	9	Recovered
	Internal hernia	Lower paramedian	5	Recovered
	Perforated diverticulum of colon	Lower paramedian	16	Died 4 months later. Wound resutured successfully
	Intestinal obstruction (band)	Lower paramedian	7	Recovered
	Cholecystitis	Rutherford Morison	13	Recovered
	? Gall-stones	Mid-line (upper)	11	Recovered
10	Same patient as 9		14	Recovered
11	General peritonitis (sup-purating dermoid)	L.	14	Died (pneu-monia)
	Secondary carcinoma	Mid-line (upper)	12	Died
	Perforated gastric ulcer	Mid-line (upper)	14	Recovered
14	Impacted foreign body	Lower paramedian	10	Recovered
15	Gall-stones (recurrent)	Transverse	14	Recovered
16	Gall-stones	Transverse	8	Recovered

From the clinical standpoint, burst abdomens are of two varieties. The surgeon may be summoned hastily because the wound has given way and coils of intestine are prolapsed on to the abdominal wall (*Fig.* 51). This is the common variety. Less frequently the wound breaks open more quietly, revealing a mass of reddish tissue beneath. One hopes that this mass is the rectus muscle, but it nearly always

turns out to be a coil of small intestine covered with granulation tissue. In other words, the abdominal wall has given way a few days before, and the prolapsed coil has only been covered by skin. Thus it comes about that if there is uncertainty as to the nature of the reddish tissue it is safer to ascertain this point in the operating theatre.

The immediate treatment is to cover the wound and the prolapsed contents with hot moist gauze. The patient is told not to cough if this can possibly be avoided. Pain and shock are singularly absent, but in order to quieten the patient and to aid relaxation under the anæsthetic, morphia, gr. $\frac{1}{4}$, is administered at once, and arrangements for operation are made forthwith.

Shipley reports that local anæsthesia infiltrated for about three inches around the wound is satisfactory. I have not yet followed this suggestion, but its possibilities in debilitated subjects are obvious. The skin of the abdomen is washed with alcohol and ether, and then painted with iodine. Towels are placed around the wound, and the prolapsed coils are washed gently with saline and returned to the abdomen. Omentum may be treated in the same way, or excised. An abdominal pad is then tucked into the wound in such a way as to keep the intestinal contents back. The wound edges are washed over with alcohol.

Fig. 51. Burst abdomen.
(After A. M. Shipley.)

It is quite useless to attempt to sew up the abdominal wall in layers. The edges of the peritoneum are difficult to define, œdematous, and will probably cut through when an attempt is made to approximate them. The following method will be found to be satisfactory in nearly all cases.

A Sargent's depressor is a useful instrument to have at hand (see Fig. 30, p. 31), and blunt hooks at the extremity of the wound are of great service (see Fig. 41, p. 38). A number of through-and-through sutures of heavy silk are passed through all the layers, including the peritoneum (Fig. 52). These sutures are introduced about three-quarters of an inch from the wound edges. They are not tied at this stage. A continuous catgut suture is then used to bring together the more superficial layers of the abdominal wall,
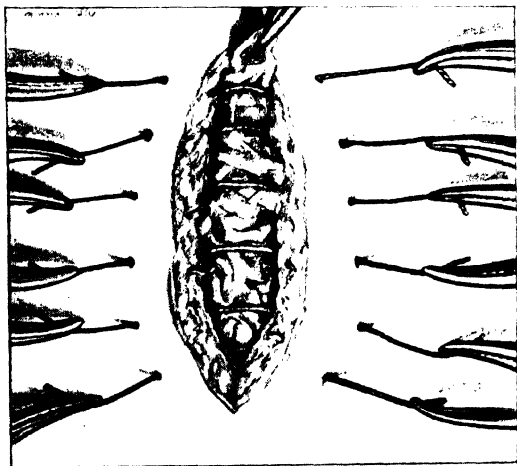
Burst abdomen. Through-and-through sutures of stout silk are passed through all layers.
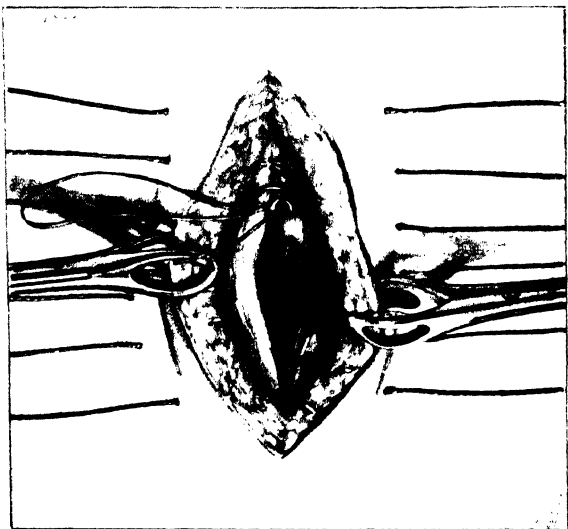
Fig. 53. Burst abdomen. Method of closing the aponeurotic layer when the sutures cut out. The skin is dissected back on either side and the needle is passed parallel to the wound edge, as is shown. E. S. 4

Occasionally, even when this stitch is passed deeply, it cuts out, owing to œdema and necrosis of the tissues. In such cases the skin should be reflected up for a short distance on either side, being careful not to cut the through-and-through sutures. If the needle is inserted parallel to the wound edge a grip of healthy tissue will be obtained (*Fig.* 53). When about half the abdominal wall is approximated, the abdominal pad is removed from the interior, care being taken that the through-and-through sutures are lying tightly beneath the incision ; it is essential to be certain that a coil of intestine has not been entrapped beneath one of them. After the continuous catgut stitch has been completed the silk sutures are tied, not too tightly, and a few skin sutures complete the operation.

As soon as convenient after the operation the patient is fitted with a pair of 'corsets' (*see Fig.* 55). The stitches should be left *in situ* for fourteen days if possible. It is remarkable that comparatively few cases of burst abdomen succumb to peritonitis, even though the intestines literally have prolapsed into the bed.

The Prevention of Burst Abdomen.—Certain conditions are known to predispose to burst abdomen. Amongst the more important are the following : (1) Violent or persistent cough ; (2) Infection of the laparotomy wound ; (3) Intestinal obstruction with distension ; (4) Escaping ferments, notably in acute pancreatitis ; (5) Hasty closure of the wound ; (6) Ascites ; (7) Extreme debility of the patient—tissues fail to heal.

There are many occasions where the accident could be prevented by supporting the abdominal wall with some form of corset.

Laparotomy corsets can be made of sheet adhesive plaster. A neat method of making the corset is that devised by R. E. Kelly.
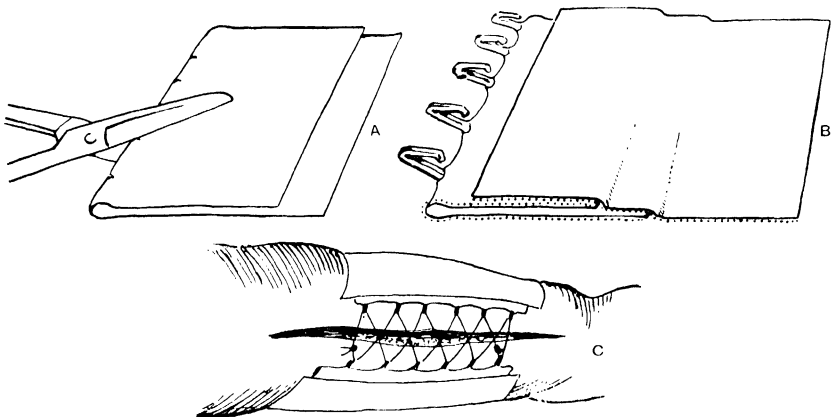
Fig. 54.—Kelly's method of fixing hooks to adhesive strapping.

A piece of strapping is folded longitudinally, not quite in the mid-line, its sticky side out. Nicks are made with scissors (*Fig. 54, A*) in the fold, just large enough to allow a dressmaker's hook, but not its flattened arch, to be pulled through. When enough hooks have been inserted a second piece of strapping is placed over the first, sticky side down (*Fig. 54, B*). The strapping is fixed to the skin parallel with and about one and a half inches from the edges of the wound. The hooks are then laced with a length of stout silk (*Fig. 54, C*).

An exceedingly good form of laparotomy corset is one ready made for use — it is usually required in a hurry. The Leukoplast corset (*Fig. 55*), made by Beiersdorf and Co., of Welwyn, answers admir-ably, and may well be at hand, for sooner or later it is sure to be needed.

DRAINAGE OF THE PERITONEAL CAVITY

Material.

1. *Drainage Tubes.* In every emergency operation these should be at hand. The 'bank-roll' method (*Fig. 56*) of storing a selec-tion of rubber drainage tubes is very convenient. The packet is
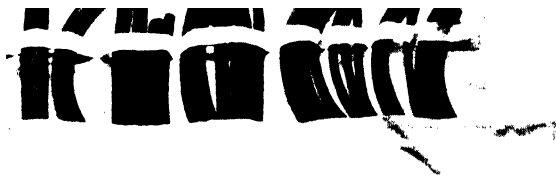
Fig. 56. The 'bank-roll' method of storing drainage tubes.

sterilized by boiling, and when a drainage tube is required the roll is unrolled and placed before the surgeon, who selects a tube to his liking. Lateral holes are cut with scissors by the operator himself. These rubber tubes are the standard drainage material used.

2. *The Split Rubber Drain.*—A rubber drainage tube of suitable dimensions is taken, and with scissors is slit completely down one side. Into the interior a wick of strip gauze is inserted. The split tube is less rigid than the unsplit tube, and is advised particularly when the path which has to be traversed is somewhat tortuous. The wick is removed at the end of the first twenty-four hours. By pulling out the wick the interior of the tube is cleared of blood-clot. I use this type of drain after cholecystectomy as a routine, and occasionally in other situations, particularly when it is desired to drain blood.

Fig. 57.—**A,** Correct method of passing a stitch through drainage tube ; **B,** Incorrect method—when the suture is tied the lumen of the tube will be almost obliterated.

3. *Corrugated Rubber* is a valuable form of drainage material. It can be cut so as to contain 2, 3, or 4 corrugations. Corrugated rubber is employed when it is desired to drain the deeper layers of a wound. Several references to it will be made later in this work.

4. *Glove Drainage.*—An old rubber glove is used. A strip about half an inch wide and two or three inches long is cut. This material is used for draining the subcutaneous space.

Gauze as a drainage material appears to be fundamentally wrong. The gauze soaks up pus or blood, which then coagulates and hinders rather than enhances drainage.

Technique of Inserting Drainage Tubes.—As far as possible avoid placing drainage tubes through the original wound. Endeavour to

Fig. 58.—Gre ge tube. The sti hes pass through one f the ridges (**R**) a l thus cannot interfere of he tube. Also leakage t the points of p rforation by the liga- is obviated.
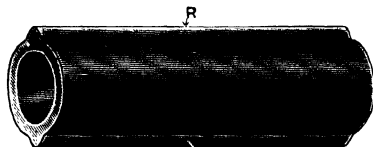
make a special stab incision to accommodate the tube only. All drainage tubes should be anchored to the skin by a stitch. This

stitch should pass through one side of the tube, and not through its
centre (*Fig.* 57); if a stitch traverses the middle of the tube, when
the stitch is tied the tube will be compressed. Greenwood's drainage
tube (*Fig.* 58) is a great improvement on the simple circular tube.
The stitch is passed through the ridge.

Insertion of a Suprapubic Drainage Tube.—Suprapubic drainage,
the best method of draining the pelvis and general peritoneal cavity,
is required most often after the abdominal cavity has been opened

Fig. 59. Supplementary suprapubic drainage.
Making the incision.
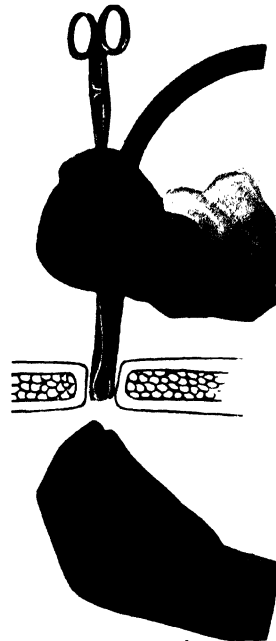
Fig. 60. Supplementary
suprapubic drainage. Method
of inserting the tube.

ady by another incision. When this is the case suprapubic drain-
may be carried out as follows. Through the original incision the
hand is introduced in the case of a laparotomy wound, or
fingers of the left hand in the case of an appendix incision, and
middle line above the pubis is sought from within. The median
ne is recognized easily by touch as a shallow trough between the
recti. By running the finger up and down in this groove it is
ertained that nothing intervenes between the peritoneum and the
ved finger. Having selected the point above the symphysis pubis,
index finger is passed to the left and the middle finger to the right

of the mid-line. Exerting upward pressure with these two fingers, cut down between them (*Fig.* 59). The cut extends to the peritoneum. If the latter is opened, so much the better; if not, the index finger pushes up the peritoneum, when it is picked up in a hæmostat and incised. The drainage tube, held in a pair of forceps, is guided by the index finger, and once within the peritoneum is grasped and conducted to the bottom of the pouch of Douglas (*Fig.* 60). After it has been ascertained that the tube is lying nicely, it is stitched to the skin. Often a further stitch is required to close the skin snugly about the tube. The excess of tubing is cut off; it is a mistake to cut it flush with the skin; it should project above the skin level about half an inch. Before the patient leaves the table it is an excellent practice to place a sterile safety-pin through the tube to prevent it being lost within—a rare but embarrassing complication (*Fig.* 61).

Fig. 61.—Radiograph showing a drainage tube wh... cavity. The ... in the rectu... ...r through the suprapul... ...m. A safety-pin through a suprapubi... accident.

Alternative Method. Many experienced operators find a thimble on the left index finger a very useful instrument. Personally, I find that the thimble robs one of the sense of touch, and it is possible to wound a coil of small intestine whilst cutting down upon the encased finger-tip.

Inserting a Drain into Rutherford Morison's Pouch. — Rutherford Morison's right kidney pouch will hold a pint of fluid without overflowing into the general peritoneal cavity or into the lesser sac. Usually drainage of this pouch is required when the abdomen has been opened already. A stab wound is made in the flank below the tip of the 11th rib (*Fig.* 62), coils of intestine being guarded carefully during the whole manœuvre. A long hæmostat is driven through the stab, and its point made to emerge in the laparotomy wound. The jaws of the forceps having been opened widely, the end of a drainage tube is insinuated between them in such a way as to grasp the whole thickness of the tube. By pulling on the forceps the end of the tube is pulled through the abdominal wall. It is important to see that the assistant does not insert the end of the tube containing the side hole into the awaiting jaws of the forceps; this end is required in the peritoneum (*Fig.* 63).
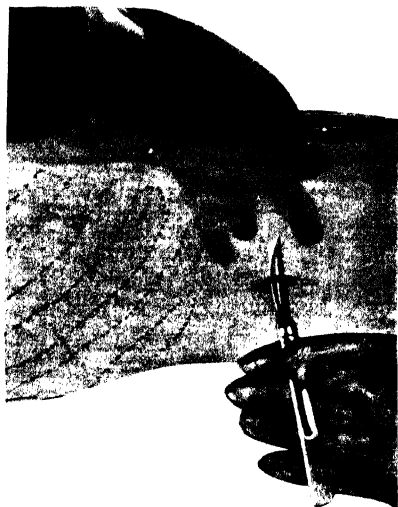
Fig. 62. Drainage of Morison's pouch. Making a stab incision in the flank.
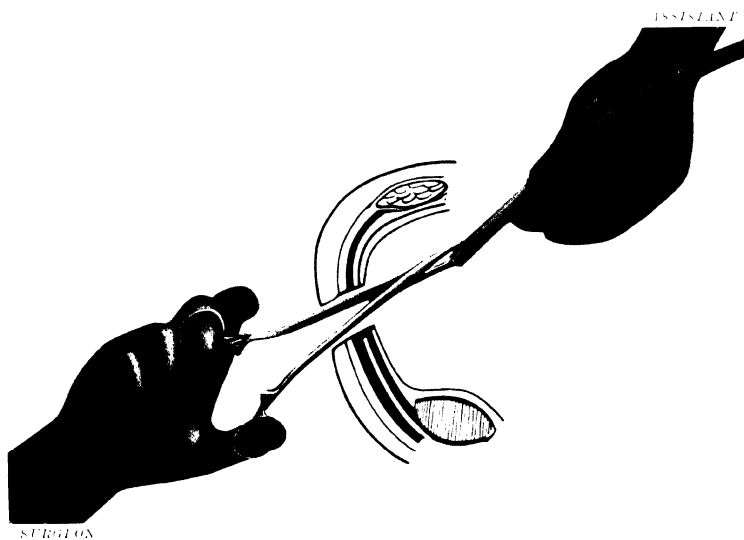
Fig. 63. Drainage of Rutherford Morison's pouch. Drawing the tube through the abdominal wall. It should be noted that the eye of the tube is towards the assistant.

Indications for Draining the Peritoneal Cavity. The past fifteen years have seen a great change in the matter of drainage. Nowadays tubes are not inserted in order to be on the safe side; indeed, the old maxim, 'When in doubt, drain', has been revised, and 'When in doubt, don't drain' is the watchword. Tolerance in the matter of drainage has done much to enhance convalescence. Faecal fistulæ are less common. Secondary hæmorrhage from pressure necrosis of the external iliac artery (due largely to the obsolete practice of passing a tube via an appendix incision into the pelvis) is an almost unheard-of tragedy. Post-operative hernia is less common. Above all, the danger of post-operative intestinal obstruction is minimized. Omitting unnecessary drainage, lessening the time drainage tubes are left *in situ*, and using special stab incisions for accommodating the tubes, have all played a part in improving results.

The peritoneum is able to deal with a large amount of infection. The great indications for drainage are : (1) The presence of free purulent material in the peritoneal sac in considerable quantities ; (2) An oozing surface where perfect hæmostasis is impossible ; (3) The presence of an abscess where the peritoneal coat is damaged (this does not imply that an appendix abscess necessarily needs immediate operation).

How Long should the Drainage Tube be left in ? It is impossible to drain the whole peritoneum for more than about twenty-four hours. Both animal experiments and necropsies following drainage of the peritoneum show that a drainage tube is isolated by plastic adhesions within forty-eight hours. After this time the drainage tube, having been shut off from the general peritoneal cavity, continues to drain the sinus it has produced for itself, and to drain this only. A tube designed to drain the whole peritoneal sac should therefore be removed at the end of forty-eight hours. In the case of a localized abscess the tube may remain for a longer time (several days). It should, however, be shortened daily.

A cynic has remarked, " Books are no good, for what book tells you when to put in a drainage tube ?" Whilst recognizing that there is an element of truth in the remark, an earnest endeavour will be made to indicate, in the appropriate sections (e.g., appendicitis), when and how to drain.

At this point it is convenient to consider Fowler's position, which is of the highest importance in the matter of drainage of the peritoneal cavity, whether drainage tubes have been used or not.

Fowler's Position. George Ryerson Fowler was born in New York in 1848, and became Professor of Surgery at the New York Polyclinic Medical School. With the help of his son Russell he

evolved what is known universally as Fowler's position. Fowler the
elder died of acute appendicitis on Feb. 6, 1906. His name must ever
be linked inseparably with *the* greatest advance in the treatment of

Fig. 64. High Fowler's position, maintained by wooden blocks, a bolster, and pillow


Fig. 65 High Fowler's position, showing the Hoskins bed-elevator and
the Burton ' donkey ' in use.

acute abdominal conditions. Tilting the patient in such a way as to favour internal drainage of the (infected) peritoneal fluid into the pelvis—which is what Fowler's position accomplishes—marks the greatest advance in the practice of acute abdominal surgery since Lister's day.

There are many ways of interpreting Fowler's position. It is essential to see that it is maintained effectively. We are accustomed to order two varieties of the position : (1) High Fowler's position: in cases of peritonitis, appendix abscess, after operations for perforated hollow viscus, and so on. (2) Low Fowler's position : after appendicectomy when the appendix is found to be unperforated, after operations for intestinal obstruction, ruptured ectopic gestation, twisted ovarian cyst, etc.

1. *High Fowler's Position.*—The head of the bed is raised eighteen inches on wooden blocks. The pillows and bolster are arranged as shown in *Fig.* 64. What is more convenient and quite as efficient as the wooden blocks is a fitting supplied by Hoskins & Sewell of Birmingham (*Fig.* 65). This bed-lifter can be attached to any bedstead. It permits the bed being wheeled about without any alteration of the patient's position.
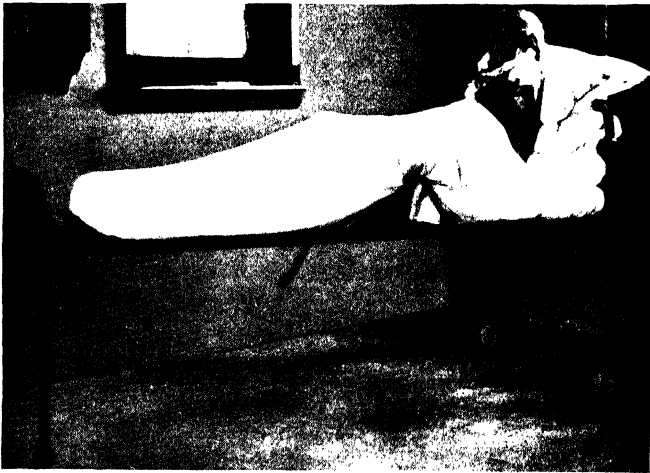
Fig. 66.—Low Fowler's position.

2. *Low Fowler's Position.*—The patient is propped up with a support beneath the knees, as shown in *Fig.* 66.

In both the high and low positions, instead of using a bolster the knees may be supported and maintained in flexion by the Burton

'donkey' (*Fig.* 67). The Burton 'donkey' has many advantages. Fowler's position is maintained strictly, the patients find it more comfortable and cooler in hot weather than a pillow, it is adjusted easily by one person, and it is more economical in the matter of linen.

When a drainage tube has been brought out in the flank, or peritonitis is localized to the right iliac fossa, in addition to Fowler's position a pillow is placed under the left loin, in order to tilt the patient somewhat on to his right side. By this means the aid of gravity in localizing infection is invoked still further.

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CHAPTER VI

PERITONITIS

In this chapter we will deal with *principles* in the treatment of general peritonitis and peritonitis of obscure origin, rather than that where the focus of origin is known. One must strive to arrive at a diagnosis, or at any rate a reasoned pre-operative hypothesis, of the source of the peritonitis. Unless a primary focus can be found and dealt with the outlook is very grave. A correct pre-operative diagnosis and a good anaesthetic are more than half the battle.

GRAVE GENERAL PERITONITIS

When the pulse is feeble and in the neighbourhood of 140 and the abdomen drumlike, or other combination of signs make it undeniable that peritonitis is frankly general, the interests of the patient are served best by adopting a conservative attitude for two or three hours, or even longer, during which time no effort is spared to get him into the best possible condition. The bulwarks of conservative treatment are as follows : -

1. Fowler's position if the pulse is not too feeble.
2. Venoclysis.
3. Concentrated anti-gas-gangrene serum, 10 c.c. intramuscularly.
4. Camphor-in-oil, min. 10, two-hourly. Three doses. Repeat if necessary. (Or other cardiac stimulant.)
5. An hourly or half-hourly pulse reading.
6. Aspirate the stomach contents if vomiting is in evidence.

In all but the moribund some improvement takes place in the general condition. If it does, the opportunity is taken of making a clinical examination once again with a view to determining the primary focus, if such was in doubt, and designing an operation to meet the needs of the particular case.

Blind Suprapubic Peritoneal Drainage. When contemplating blind suprapubic drainage for a desperate case of general peritonitis, the reader is exhorted to refer to pp. 92, 93 before deciding to carry out the measure, particularly if the primary focus is probably a perforated appendix. In cases of dire necessity suprapubic drainage can be carried out in bed ; by the time the patient's condition is so grave as to make this the method of choice there is but little hope.

Local anaesthesia should be employed.

First pass a catheter—the only method of ensuring an empty bladder. Make a short incision immediately above the symphysis pubis, and having opened the peritoneum, pass in a finger towards the rectovesical pouch. Along this track push a drainage tube mounted on a long hæmostat.

In performing this operation with the patient in bed I have found it convenient to break through the peritoneum with the forefinger. Advantages of this crude method are that a much smaller incision can be used and the operation completed in a moment. Also complications, such as prolapse of a loop of intestine (for which we are not prepared adequately when operating in these circumstances), are avoided. Admittedly an unscientific method, it is to be recommended only under the most extenuating circumstances.

Simple suprapubic peritoneal drainage is indicated occasionally, but less urgently, in pelvic abscess. The same precautions of ensuring that the bladder is empty must be observed.

General Peritonitis; Condition of the Patient Fair.

Anæsthesia. To carry out intraperitoneal manipulations deftly and expeditiously is all-important in the operative treatment of general peritonitis; a poor general anæsthetic makes this impossible. In general peritonitis, if the patient is rigid and straining under the anæsthetic, his chances of survival are nearly halved. On this account I think the advantages of a spinal anæsthetic, using a smaller dose than usual and supplementing it with a little general anæsthesia, outweigh its disadvantages. If the blood-pressure is low, open ether is advised. Unless the anæsthetist is particularly skilled, gas and oxygen administered to a patient with a distended abdomen adds to the difficulties of the surgeon's task, sometimes making it almost insuperable.

Operative Technique when the Focus of Origin is Uncertain.

Some recommend beginning by draining the peritoneal cavity suprapubically. "Suprapubic drainage will be needed in any case", they say; "furthermore, by observing the nature of the exudate the key to the situation will be found." My experience is opposed to this teaching. To open the abdomen deliberately through a really small suprapubic incision is distinctly difficult. Moreover, by observing by sight and smell the fluid which wells up, I have failed, often miserably, to diagnose the primary lesion. As to the utility of the incision for purposes of drainage, one feels that the tube could be placed more quickly and accurately had the abdomen been opened elsewhere and the suprapubic drain passed through a stab incision.

In cases of general peritonitis where it is impossible to diagnose clinically the primary focus I think the best procedure is as follows.

Open the abdomen by a gridiron incision and inspect the appendix. At any rate the appendix can be scrutinized by this route. If it is found to be perforated the search is finished; if inflamed, but not perforated, remove it and pass it to someone in the theatre to slit up. *If the appendix is more inflamed on the outside than the inside the organ is innocent—search elsewhere.* By way of a gridiron incision a suprapubic drainage tube can be inserted accurately into the rectovesical pouch after a special stab wound has been made.

Unless clinically there is some definite hint as to where to open the abdomen, the foregoing method will be found to be a practical one. The gridiron incision is made quickly and can be closed easily if it should prove to be unsuitable. The only exception is in the case of a female, where the adnexa as the primary source of the trouble must be excluded. In this instance exploration may be commenced by making a Battle's incision.

Subsidiary Operative Measures.—Experience has shown that when a patient with considerable peritonitis develops a post-operative faecal fistula he usually recovers. This knowledge has been the starting point of the growing practice of providing a small vent in the gut at the conclusion of an operation for widespread peritonitis. This vent may take the form of a caecostomy or an enterostomy.

Primary Caecostomy.—To sew a catheter into the caecum at the conclusion of an operation for peritonitis with considerable distension is a rational procedure. Through the tube gas and faecal matter escape, thereby adding to the patient's comfort. The tube obviates the need for enemata, which are exhausting. The tube in the caecum can be used also for the administration of saline. After the saline has been introduced the tube is clipped for half an hour. If the abdomen has been opened by a gridiron incision the caecostomy tube can be brought through the original incision. In the case where laparotomy has been performed by another route it is best to make a small gridiron incision and perform caecostomy through this. A portion of caecum is delivered and isolated by a pack. A purse-string is inserted. A small puncture is made with a narrow-bladed scalpel and a quarter-inch drainage tube or a rubber catheter is pushed into the caecum. Having anchored the tube to the caecal wall the purse-string is tied. This is followed by two further invaginating purse-string sutures. Using interrupted sutures, the peritoneum is stitched accurately to the caecal wall close to the tube. The muscles and skin are approximated about the tube.

Easton and Watson have recommended that the caecal drainage tube at the time of its insertion be passed through the ileocaecal valve (*Fig.* 68). I have found this not very easy to accomplish

through a small incision, and I hardly think the additional manipu-
lation is justified.
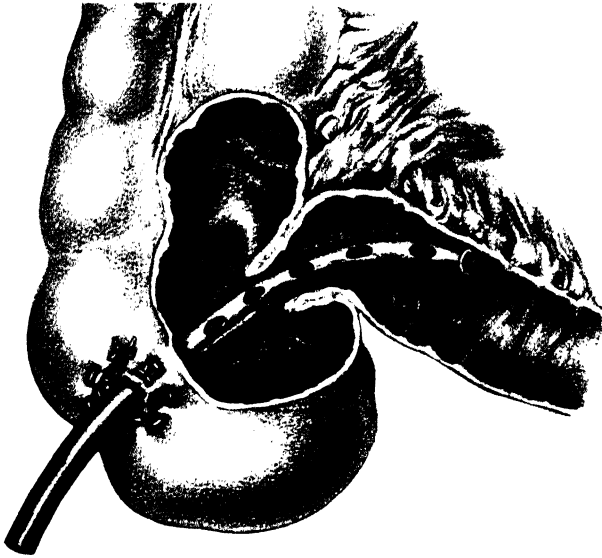
Fig. 68.—Cæcostomy with drainage of the ileum.
(*After Easton and Watson.*)

Primary Enterostomy.—When the peritonitis is diffuse, and the gut
distended, with a dull and lustreless peritoneal coat, enterostomy,
rather than cæcostomy, is recommended by many excellent authorities.
I have not made much use of this measure myself, but I can
understand the rationale of the procedure. If enterostomy is con-
templated it must be performed aseptically by Wagensteen's technique
(p. 226).

Whether a cæcostomy or an enterostomy has been performed
the tube should be left in until the catgut stitch which anchors it to
the gut has disintegrated, when the tube will be extruded spontaneously.
Usually the fæcal fistula closes without incident.

After-treatment.—If possible, arrange for a special nurse to take
charge of the case. As soon as the pulse permits, the patient is
placed in the high Fowler's position. Nothing but water is allowed
by mouth for at least four days, and sometimes longer. If vomiting
is in evidence continuous gastric aspiration (p. 101) should be em-
ployed. Saline infusion is almost the breath of life to these patients.

Venoclysis is usually the best method, but if a primary cæcostomy has been performed the ascending colon will absorb greedily pints of saline and glucose. Anti-gas-gangrene serum, the contents of one capsule, is injected intramuscularly each day for four or five days. Acetylcholine, 0·1 grm. intramuscularly four-hourly, until the bowels or enterostomy have acted freely, does no harm and may do good in forestalling paralytic ileus.

Pneumococcal Peritonitis. — Pneumococcal peritonitis is either primary, or secondary to pneumonia. Of eight cases under the writer's care, three belonged to the second category. Pneumococcal peritonitis often leads to difficulty in diagnosis. A leucocytosis of 30,000 to 70,000 with about 90 per cent polymorph speaks more for pneumococcal peritonitis than appendicitis. The mortality of the condition is so disheartening that Rischbieth in 1910 advocated no operative interference unless an encysted collection of pus formed.

McCartney and Fraser strike a note of encouragement in their study of 56 cases occurring at the Children's Hospital, Edinburgh. They believe that early operation offers the best prospect. Some of their best results followed vaginal drainage. The anæsthetic must be gas and oxygen or local. Results have improved considerably by the addition of blood transfusion. " It is important to recognize the precise time at which the transfusion can be done with the greatest possible advantage. That point is when the evidences of septicæmia are just beginning to make their appearance. That is very definitely the period of election ; if done earlier the transfusion does not appear to prevent the onset of septicæmia ; if done later the heart may be so weakened that the quantity of blood which can be introduced safely is so small that relatively little beneficial effect can be looked for. As regards the quantity of blood which can be given to a child say of six years, we aim at the administration of 250 c.c. The change which the administration induces is often dramatic— the cyanotic tinge disappears and is replaced by a healthy rosy colour, the restlessness abates, the pulse-rate slows, and the patient often drops into a sound sleep " (McCartney and Fraser). Using this technique their mortality figure has fallen to 42 per cent.

The operation consists of drainage of the peritoneal cavity. Owing to the difficulty of excluding appendicitis it is often advisable to commence by making a gridiron incision. If the appendix is found to be innocent, it should be left. Making a gridiron incision adds almost nothing to the time consumed by the operation, for insertion of the suprapubic drain is the work of a moment, and most operators find it easier to get the tube into the desired position via the gridiron incision than by working blindly through a small suprapubic incision.

General Peritonitis following Parturition or Abortion.—When the infection is limited strictly to the pelvis the Ochsner-Sherren régime (p. 82), followed when necessary by posterior colpotomy (p. 295), is eminently successful. We are considering here a more extensive peritoneal involvement. It is the considered opinion of those who have had much experience of these cases that operation should be carried out as soon as possible, even though the patient appears to be very ill. The abdomen is opened by a right paramedian incision. If there is an abscess of the wall of the uterus or the broad ligament, after packing off the area as rapidly as possible, the abscess is opened with sinus forceps and a drainage tube is introduced into the abscess cavity, if this be large enough to admit one. In any case the peritoneal cavity is drained by *two* drainage tubes passed into the pelvis, one in front of the uterus and one into the pouch of Douglas.

Primary Streptococcal Peritonitis is fortunately rare, for it is very fatal. Probably appendicitis with peritonitis will be diagnosed. The appendix is found inflamed on the *outside*, but not perforated. The pus is usually thin, and sometimes the peritoneal exudate is blood-stained. Meteorism may be extreme, causing the condition to be confused with intestinal obstruction. In this connection the following case is of some interest :—

I was asked to see a woman of 37 on the medical side, who had been admitted as (?) typhoid. She was gravely ill and the abdomen was greatly distended. There had been no result to an enema, and she had vomited small amounts repeatedly.

Examination showed a small right femoral hernia. Operation was advised on the diagnosis of a strangulated Richter's hernia.

On opening the sac pus was found within, also a small piece of omentum, which was reduced readily into the peritoneal cavity. She was too ill to warrant anything but drainage, so I passed my finger up the femoral canal and cut down upon it in the suprapubic region. In so doing I pricked my finger. In spite of the usual precautions I had a rigor five hours later. The pus from the peritoneum grew a streptococcus. The woman died, and at the necropsy general peritonitis was found, but without any demonstrable primary focus. I consider myself fortunate to have escaped with the loss of my left index finger.

Suprapubic drainage, continuous intravenous infusion, and anti-streptococcal serum form the only treatment for this very grave condition.

In the following table are given details of 5 consecutive cases of primary streptococcal peritonitis which were proved bacteriologically, and, except in the solitary instance of recovery, by the failure to find a primary focus at necropsy.

PRIMARY STREPTOCOCCAL PERITONITIS.

1	F.	53 years	Suprapubic drainage only	D.
2	M.	2½ „	Normal appendicectomy Suprapubic drainage	D.
3	F.	37 „	Femoral sac opened Suprapubic drainage	D.
4	M.	6 „	Normal appendicectomy Suprapubic drainage	R.
5	M.	5 „	Normal appendicectomy Suprapubic drainage	D.

Gonococcal Peritonitis. Cases of generalized peritonitis which appear to arise from gonococcal salpingitis are met with from time to time. In several cases which are believed to belong to this group suprapubic drainage has resulted in recovery. In two of them the pus was sent for culture, but was reported upon as being sterile. This is probably due to the fact that the gonococcus when removed from its habitat is a frail organism.

Internal Fæcal Fistula.—J. M. Petty has done a service in calling attention to this condition. Internal fæcal fistula should be suspected when the patient suddenly develops signs of general peritonitis about the fourth day after appendicectomy. A large enema is frequently the determining cause and the appendicular stump bursts open.

Once the condition has developed the only possible treatment is immediate operation and the conversion of the internal fistula into an external one. This complication, which is probably not as rare as may be thought, could be prevented by sewing a catheter into the cæcum in those occasional cases where the cæcum is much distended and the tissues about the appendix stump œdematous.

Acute Tuberculous Peritonitis.—Acute tuberculous peritonitis—or, more correctly, an acute exacerbation of chronic tuberculous peritonitis—usually comes to operation on account of an error in diagnosis. It is almost impossible to diagnose correctly many of the cases.

On opening the peritoneum a varying amount of free fluid, usually clear and straw-coloured, escapes. Tubercles are seen scattered over the peritoneum and the great omentum. Tubercles may be confused with fat necroses. The latter are more yellow, and often associated with a blood-stained peritoneal exudate. Nevertheless, the writer has seen a case in which it was most difficult to decide between fat necroses and tubercles until the swollen, purple pancreas was displayed, and left no doubt that it was a case of acute pancreatitis. Again, peritoneal carcinomatosis may on occasions easily be confused

with tuberculosis. The tiny multiple deposits of carcinoma feel hard when rolled between the finger and thumb, making their recognition tolerably simple.

On opening the abdomen and finding acute tuberculous peritonitis, a piece of omentum may be removed for histological examination, and the wound is then closed without drainage.

A troublesome, but rare, complication is the development of tuberculous ulceration in the wound.

Other Aspects of Tuberculous Peritonitis in Relation to Acute Abdominal Surgery.—

M. K., aged 21, was admitted with hypogastric pain extending over six days. The pain commenced abruptly, and she vomited twice.

On examination the pulse was 108 and the temperature 100·8 . There was a fullness in the lower abdomen, dull to percussion, which persisted after the passage of a catheter. A rectal examination was negative. A leucocyte count showed leucopenia. A diagnosis of (?) twisted ovarian cyst was made.

Laparotomy showed tuberculous peritonitis, with a loculus containing a pint of clear fluid which was drained off, and the resulting cavity was mopped dry. The abdomen was then closed without drainage.

Recovery.

F. J., aged 19, was admitted in a very grave condition with an indefinite history of abdominal pain extending over five weeks. She had vomited once on the day of admission. The pulse was 120 and the temperature 100 . The abdomen was greatly distended.

On opening the abdomen there was plastic tuberculous peritonitis. Behind the umbilicus there was a cystic mass composed of loops of ballooned small intestine adherent to one another. It was impossible to find even one loop of small intestine which was not diseased. Therefore nothing was attempted, and the abdomen was closed, with the resolve to perform jejunostomy if urgent obstruction developed. For some reason or other she improved after the operation. The bowels moved regularly. She was discharged a month later.

When written to two years later, her mother replied that F. J. was in a sanatorium, and was progressing " quite well ".

Fig. 60. Marsupialization of a large tuberculous abscess of the mesentery.

E. H., aged 6, gave a history extending over three days of attacks of colic lasting about three minutes and recurring every twenty minutes.

Her mother stated that her bowels had not been open, but that a large quantity of mucus had been evacuated.

On examination the pulse and temperature were normal, and the child did not appear very ill. There was a lump in the hypogastrium which also could be felt per rectum. An enema yielded a small faecal result and a considerable amount of mucus. The diagnosis was doubtful. An appendix abscess was suggested, also an anomalous intussusception.

Laparotomy showed a large tuberculous abscess in the mesentery of the lower third of the ileum. The peritoneum was sewn around the wall of the abscess so as to marsupialize it (*Fig.* 69). The abscess was then drained, a large amount of tuberculous pus being evacuated.

Recovery. When seen two years later she was perfectly well, but there was some keloid formation in the scar.

Peritonitis due to Suppurating Mesenteric Glands.

T. W., aged 20, was admitted with the following history. Whilst lying down he was seized with violent abdominal pain. There was no vomiting. The pain continued unabated and was all over the abdomen. The pulse was 120 and the temperature 102 . Rigidity was almost general but the right upper quadrant was relaxed moderately. The maximal tenderness was in the right iliac fossa. The diagnosis of perforated duodenal ulcer was considered, but it appeared that the temperature of 102 made this diagnosis unlikely.

The abdomen was opened by a gridiron incision, and the appendix examined. The organ was removed and slit up. Its mucous membrane was found to be normal. As there was much turbid fluid in the general peritoneal cavity it was thought that after all the patient had a perforated duodenal ulcer. The gridiron incision was closed and the upper abdomen opened. There was no perforation, but a mass of suppurating glands in the jejunal mesentery. Suprapubic drainage.

Recovery.

Suppurating mesenteric glands giving rise to general peritonitis are not exceedingly rare. The correct diagnosis is impossible. In two other very similar cases the same treatment was adopted and both recovered; these patients were both males. 27 and 30 years of age respectively.

Peritonitis from Perforated Typhoid Ulcer. –If it is known that the patient is suffering from typhoid the diagnosis is not particularly difficult. I have, however, seen two cases in which perforation occurred in a patient with ambulatory typhoid. The perforation will be found in the last two or three feet of the ileum. It should be stitched up and suprapubic drainage instituted.

Peritonitis due to a Perforating Foreign Body.—It is not a great rarity to encounter general peritonitis without a definite primary focus. Probably a proportion of these cases are due to perforation of some part of the intestinal tract by a foreign body, such as a bristle, which never comes to light. Sometimes the foreign body is large enough, accessible enough, and the patient well enough, for the

lesion to be discovered by a systematic search. At others we may have the good fortune to blunder across the offending object.

J. H., a stout man of 56, was admitted with what appeared to be a typical attack of acute appendicitis with peritonitis.

A gridiron incision was made, and thin pus welled up into the wound. The fingers were inserted into the wound for the purpose of withdrawing the caecum. This manœuvre was hardly begun when I hastily withdrew my hand, for something had pricked my finger. Further investigation showed that the last coil of ileum had a spiked object sticking through its walls. This was extracted, the perforation closed, and the peritoneal cavity drained.

Recovery.

The foreign body is shown in *Fig.* 70 : it is composed of celluloid.

Fig. 70. A foreign body made of celluloid found perforating the lower ileum in a case of general peritonitis.

The patient could throw no light on its origin.

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CHAPTER VII

ACUTE APPENDICITIS

In the case of acute appendicitis seen within the first forty-eight or fifty hours of the attack no question arises as to the best line of treatment. It is agreed universally that the appendix should be removed without delay. Appendicectomy under these circumstances is one of the most satisfactory operations in surgery.

APPENDICECTOMY DURING THE FIRST FORTY-EIGHT HOURS OF AN ATTACK OF APPENDICITIS

Instrumentarium. The instruments used by the author are shown in *Fig.* 71. To reduce the number of instruments to the minimum compatible with efficiency makes for an orderly technique.
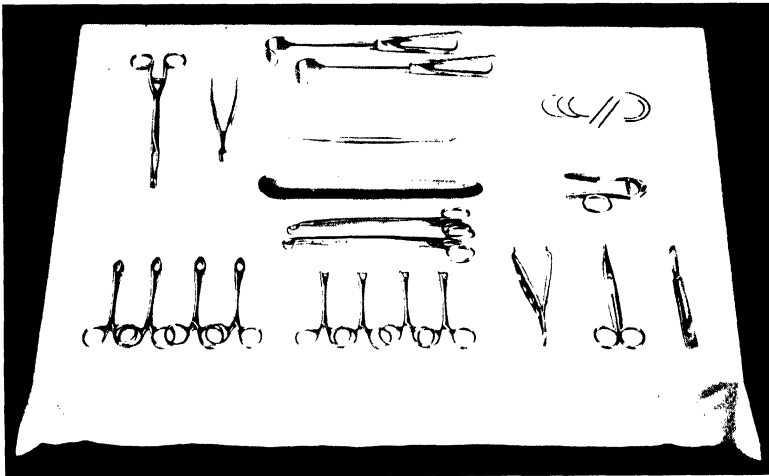
Sponge- Forceps   London Hospital retractors
holding   for   Watson Cheyne dissector
forceps inverting   Sargent s depressor
            the   Moynihan s tetra clips
          appendix   Towel holding clips
Morrant Baker forceps

Fig. 71.—Instruments for appendicectomy with the exception of hæmostats, which are on a separate table.

The Incision.—The *gridiron incision* (p. 42) made over McBurney's point (*Fig.* 72) is the best one for the removal of an acutely inflamed

appendix. If the method which has been described for enlarging the incision in necessary cases is followed, the sole objection to the gridiron —namely, limitation of space—fades into insignificance.

Battle's incision (p. 45) answers its purpose well. The main points in its favour are that it is enlarged readily and it gives good access to the internal female generative organs.

The *paramedian incision*, employed for the designed removal of an acutely inflamed appendix, should, I believe, be condemned. The appendix is often comparatively inaccessible from this approach. By
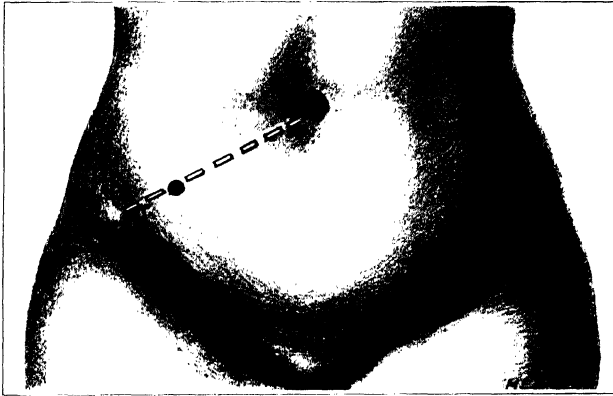
Fig. 72.—McBurney's point lies upon the line shown 1½ in. to 2 in. from the anterior superior iliac spine. This point is often incorrectly given more medially.

using an incision so near the middle line it is possible to contaminate the medial portion of the peritoneum in cases where the infection was strictly localized. The small intestine is not packed off so readily as in the foregoing incisions.

Technique.—We will assume that the abdomen has been opened by the gridiron incision. Place a retractor under the medial side of the peritoneum and lift up the abdominal wall (*Fig. 73*). This allows one to peer into the peritoneal cavity and to see the state of affairs before anything is disturbed. It is often possible to see the cæcum, and occasionally the appendix also. If pus or purulent fluid welled up when the peritoneum was opened, pack a strip of gauze under the mesial side of the peritoneum and re-apply the retractor over this before attempting to deliver the cæcum. It should be needless to emphasize that nothing must enter the peritoneal cavity without having a hæmostat attached. Pick up the cæcum between finger and thumb and draw it out; if it is difficult to grasp, Russell Howard's rubber-covered forceps are of distinct value. Used

Fig. 73. Appendicectomy. Before attempting any intraperitoneal manipulation a retractor is placed under the medial side of the wound and the abdominal wall is lifted up. The surgeon then peers inside before anything has been disturbed.

Fig. 74. -Appendicectomy. The cæcum is held by an assistant. Morrant Baker forceps have encircled the appendix and the meso-appendix is displayed.

with a very light touch, without engaging the rachet, Denis Browne's forceps are a good substitute. Once a portion of the cæcum has been drawn through the wound it should be grasped by the fingers holding a gauze swab. Using the swab, the cæcum is pulled gently, and usually the appendix will come into view. The finger may be inserted into the wound to aid very gentle delivery of the appendix. Once the appendix has been delivered the cæcum is given to an assistant to hold. He should be instructed to take a good grip and hold the slippery struc- ture in a gauze swab (*Fig.* 74).
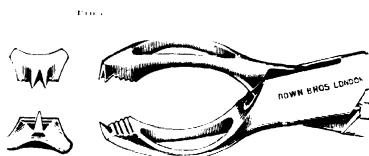
Fig. 75. Morrant Baker forceps.

Morrant Baker forceps (*Fig.* 75) are applied around the appendix in such a way as to encircle the organ and yet not damage it (*Fig.* 76). Clipping then cutting, section by section, the meso-appendix is severed, until the base of the organ is reached. A long hæmostat is applied to the base of the appendix. It is released, and applied
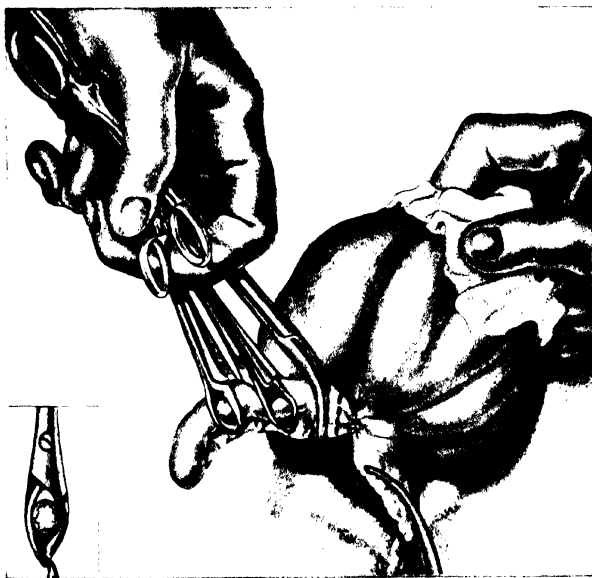
·h the appendix is removed by cutting across its base between

mt Baker's forceps in use grasping the appendix without reeps with one tooth cannot be employed satisfactorily for etion is applied the meso-appendix is torn by the single tooth.
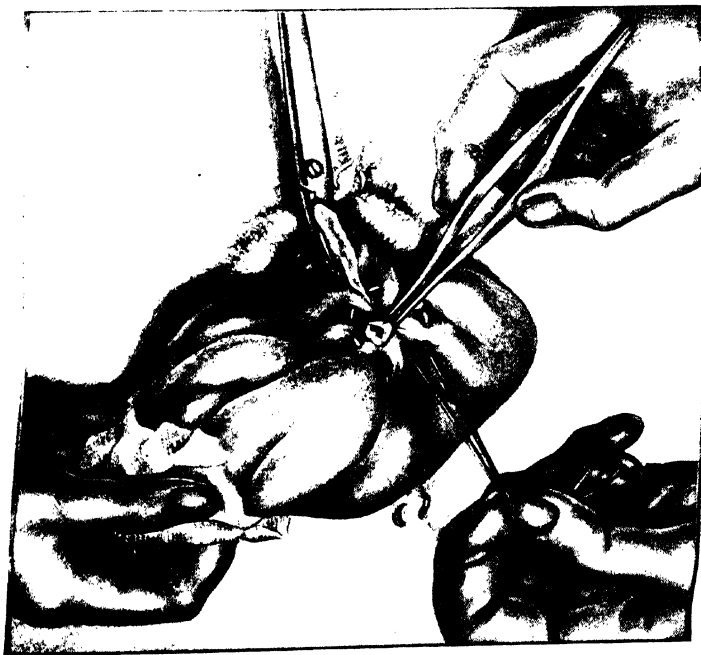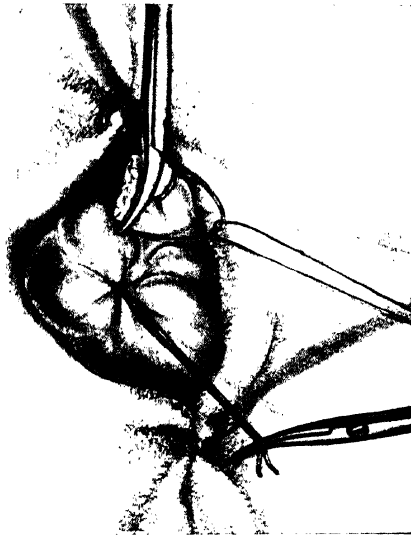
again a few millimetres more distally (*Fig.* 76). Around the crushed portion a ligature is applied, tied, and its ends cut short. A purse-string suture is inserted to encircle the caput cæci about half an inch from the appendix. This stitch passes through the muscular coat, particularly at the longitudinal bands. The purse-string having been inserted, it is momentarily left untied while the appendix is severed between the hæmostat and the ligature (*Fig.* 76). The appendix, hæmostat, and Morrant Baker forceps are now free in the left hand and the scissors are in the right. All these are cast into a special dish because they are infected. The free ends of the purse-string are held moderately taut whilst the stump is wiped with a gauze swab which is thrown away promptly; alternatively or in addition the stump is touched with a drop of pure carbolic acid. The appendix is invaginated with a smooth small pair of dissecting forceps (*Fig.* 77). The purse-string having been tied, the cut ends are left long and grasped in a hæmostat. Attention is directed to the ligaturing of the meso-appendix. For this purpose I always use trans-fixion sutures (*Fig.* 78), which are safer than a simple ligature. I have seen at necropsy a hæmatoperitoneum resulting from a slipped ligature on the meso-appendix. The transfixed ligature cannot slip.

Finally, in selected instances the long ends of the ligature which has been applied to the meso-appendix and the ends of the purse-string may be knotted (*Fig.* 79), thus obliterating any cut edge of peritoneum. This step is only attempted when there is absolutely no tension between the structures involved.

Dangers and Difficulties.—

On 'Hooking out' the Appendix.—An experienced surgeon can and does sometimes put in a finger and hook out the appendix. This is all very well for one who, from experience, can estimate the mobility of the organ and compare it with his incision. With much practice it is possible by a glance and a touch to recognize the flexibility or friability of a particular appendix. To the beginner, hooking out the organ

Fig. 79.—Appendicectomy. Knotting gether the ligature which has been applied the meso-appendix and the long ends of

is fraught with danger. The most dangerous appendix to attempt to hook out is one situated in the pelvis. Sir Frederick Treves

in his well-known sketch "The Idol with the Hands of Clay" depicts graphically the fatal termination of an operation for appendicectomy by a sudden hæmorrhage. It is possible that the external iliac artery was hooked up, for this artery may feel very like the continuation of a pelvic appendix. The safest method of delivering the organ is by gentle traction of the cæcum. The finger may be used to ease the appendix through the abdominal wall, but this is not what is understood by hooking. If the appendix does not come out kindly it means that more room is required.

The Appendix Cannot be Found. Make certain that it is the cæcum which has been delivered. The transverse colon is recognized at once because of the attachment of the transverse mesocolon. Having made sure that it is the cæcum, trace a tænia coli downwards; this must lead to the base of the appendix. If still in trouble enlarge the wound, and after locating the ileocæcal valve (the appendix must be near this structure), palpate the back or under surface of the cæcum, for the appendix may be buried in the cæcal wall. If the patient has not had a previous abdominal operation, the only remaining possibility is that the organ has become inverted or intussuscepted. The umbilicated extremity of the cæcum should make this rare occurrence obvious.

Fig. 80.—Showing how the proximal end of the appendix may be buried in the cæcal wall, and the cuff method of ensuring total appendicectomy. (*After A. Edmunds.*)

Has All the Appendix been Removed?— The end of the appendix is dome-like, and rarely, if ever, is there a perforation exactly on the convexity of the dome. If the tip of the organ has not been removed with the rest of the appendix, a probe passed along the lumen of the excised portion will demonstrate if part is missing. Never leave behind a piece of detached appendix; the blood-supply has been cut off, and consequently gangrene and liquefaction of the infected fragment is almost certain to follow. The proximal end of the appendix, when buried in the cæcal wall, has been overlooked many times (*Fig.* 80).

The Meso-appendix is Gangrenous and Cuts Out.— This is not uncommon, and is a trying complication, especially in the obese. If a ligature will not hold, a stitch applied directly beneath a spurting point may stop the flow. A gauze pack moistened with a little

turpentine and left *in situ* for about thirty seconds at a time will often stop considerable oozing. Recourse may have to be made to packing the area for forty-eight hours. The necessity for this step is a great rarity, and it should not be resorted to unless the circumstances are most exceptional.

The Appendix has Sloughed Off.—Usually the meso-appendix anchors the organ in the field of operation. On one occasion only I found that the bulk of the appendix was missing. After dealing with the stump the wound was enlarged and a free appendix was retrieved from the pelvis without much difficulty.

The Appendix is Lying against the General Mesentery and the Inflammatory Process has Implicated the Latter.—Usually the appendix can be dissected uneventfully from the mesentery. In one case (of forty-eight hours' duration) I found that after the appendix had been separated the mesentery of the last inch of ileum was bleeding seriously. Attempts to stop the hæmorrhage by ligature were only successful after several ligatures had cut out. When the bleeding was quelled finally it was noticed that the last two inches of ileum were blue; the blood-supply had been interfered with seriously. This segment was therefore resected and ileocæcostomy performed. Recovery followed.

Retrograde Appendicectomy.

Indication. When the circumference of the base of the appendix is more accessible and definable than the distal part of the organ. Retrograde appendicectomy is useful particularly in retro-cæcal appendicitis when the extremity of the appendix is embedded in the cæcal wall or attached to retroperitoneal structures yet the base of the organ is comparatively free (*Fig.* 81).

Fig. 81.—Gangrenous retrocæcal appendix attached to the lower pole of the kidney. An indication for retrograde appendicectomy.

Technique.—The base of the appendix is inspected and a Morrant Baker's forceps is applied a little distance from the cæco-appendicular

junction in such a way that the appendix lies within its lumen. A little blunt dissection may have to be done before this step is possible. Gentle traction then pplied to

Fig. 82. Retrograde-appendicectomy. The ase of the appendix has een isolated with the robe end of a Watson heyne dissector. Two æmostats are applied in 1e manner shown, and the appendix is divided between them on to the director which can also be seen.

Baker's forceps, and the interval between the appendix and the cæcal wall becomes apparent. The probe end of a Watson Cheyne's dissector is passed (through the meso-appendix) under the appendix, and two pairs of hæmostats are applied to the appendix close to one another, at this spot (*Fig.* 82). The appendix is divided between them ; the scalpel which has been used

Fig. 83. Retrograde appendicectomy. The base of the appendix has been divided and the appendicular stump invaginated. The appendix is in the course of being removed from the base to the tip.

for this purpose is put aside, for it is infected. The cut surfaces of the appendix are wiped carefully and touched with iodine or carbolic.

The distal end of the appendix is now excised in the following manner. By gentle

traction on the hæmostat which grasps the cut end, aided by a little gauze and perhaps here and there blunt dissection, the ill-defined meso-appendix becomes sufficiently demonstrable to clip and cut, c͡b and cut, until the whole organ is removed (*Fig.* 83).

As far as the cæcum and the severed base of the appendix are concerned the procedure is straightforward. A ligature is applied to the base of the appendix and a purse-string suture is inserted; the hæmostat which clamped the base is removed. After cutting off the fragment of crushed tissue which was held in the jaws of the forceps the base of the appendix is buried by the purse-string in the usual manner. Ligatures having been applied, the bed in which the appendix lay may be obliterated by a running suture. It is in this type of case that the last step is often particularly satisfactory.

Retrograde appendicectomy is an excellent measure in selected cases, and renders easy what might prove an extremely difficult operation. But it must not be abused. *It is necessary to have the whole course of the appendix under vision before the operation is commenced*, otherwise a portion of a gangrenous organ is liable to be overlooked.

Submucous Resection of a Buried Appendix. A method recommended by Kelly in his work on appendicitis. The principle of the operation is that the base of the appendix is divided and embedded in the manner just described; the serous and muscular coats are incised, and the appendiceal mucosa is then shelled out, commencing at the base.

I have only practised this operation once, and that was in one of my earliest cases. The shelling out of the mucosa went on until about half an inch from the tip; here it was gangrenous and quite impossible to enucleate by this means. The gangrenous portion was therefore scraped out and a drainage tube inserted. Subsequently the boy developed general peritonitis and died. Such an experience is likely to prejudice one, but it is my belief that removal of all coats of the organ should be practised invariably.

Drainage. Drainage of the peritoneal cavity is absolutely necessary when an appreciable amount of frankly purulent fluid is present. In other instances, if there is any fluid to be mopped up, this is done; the incision is then closed with the exception of a corrugated rubber drain in the subcutaneous space, which is seldom omitted.

Drainage is *not* usually necessary:—

1. In unperforated appendicitis however evil the organ may look.

2. In cases where the appendix breaks or bursts during removal.

3. In recent perforation with a local serous or sero-purulent exudate. (By recent perforation is meant that there was no pre-operative distension or considerable acceleration in pulse-rate.)

Is there an Appreciable Amount of Pus or Purulent Fluid in the Pelvis?—This is perhaps the major problem before closing without drainage. With experience the question seldom arises, for it is

answered soon after the abdomen has been opened. The amount and the nature of the fluid which escapes when the peritoneum has been incised, the appearance of the interior when one peers into the peritoneal cavity before disturbing the viscera, the position of the appendix, the pre-operative rectal examination, and the pulse-rate are all factors which are taken into consideration.

In cases of real doubt a small swab on a holder is passed down into the pelvis through the incision, withdrawn, and inspected by sight and smell. This diagnostic swab will tell if a suprapubic drain is needed. The method should not be employed promiscuously. There is a danger, according to Sampson Handley a very real one, of spreading infection from the right iliac fossa into the pelvis. The need for the diagnostic swab is only likely to arise when the appendix was pelvic, or purulent fluid was seen to well up from the pelvis at one step of the operation; and if used only when there is a definite lead, and not ' to be quite certain ', the method is more than justified.

Where to Insert the Drainage Tube. A suprapubic drainage tube through a special stab incision above the pubes is an excellent and life-saving measure in general and pelvic peritonitis.

It is never necessary to put a drainage *tube* through the original appendix incision, except when deliberately draining an appendix abscess. The most pernicious practice of all is to pass a long tube through the original incision into the pelvis. In this instance the tube takes a very oblique course, which is in itself enough to condemn the method; but in addition pressure necrosis of the external iliac artery by the tube is a possible complication, by no means unknown when this method was practised extensively.

A stab incision in the flank is useful when it is necessary to drain the retrocaecal space. The incision is made about two inches behind the anterior superior iliac spine, and not too near the crest of the ilium, for that part is more vascular. This provides good dependent drainage, which is made more efficient when the patient is nursed with a pillow under the left loin. Drainage of the retrocaecal space is required comparatively rarely. The whole question of drainage in acute appendicitis has been simplified by the introduction of the corrugated rubber drain. If the operator feels nervous about closing without drainage, a narrow piece of corrugated rubber brought out through the incision cannot do harm, especially if it is removed at the end of twenty-four or forty-eight hours.

Primary Caecostomy.—When there is considerable intestinal distension a catheter introduced into the caecum will do much to lessen the anxieties of the post-operative period. The rationale and the technique of the procedure have been discussed on p. 62.

Anti-gas-gangrene Serum. At the conclusion of an operation for appendicitis with peritonitis it is a wise precaution to administer the contents of an ampoule of anti-gas-gangrene serum intramuscularly.

Intravenous Mercurochrome. — The removal of a gangrenous appendix, even when the intra-abdominal manipulations are reduced to a minimum, must tend to increase temporarily the amount of toxin entering the blood-stream. At the conclusion of every operation for gangrenous appendicitis 10 c.c. of mercurochrome solution may be injected intravenously with the idea of helping the patient to combat his infection at a period when his resistance is low. May and Baker put up mercurochrome solution suitable for intravenous injection in phials of 10 c.c.

WHERE THE DIAGNOSIS OF APPENDICITIS IS IN ERROR

It is not our intention here to dwell upon the various conditions which may be, and have been, mistaken for appendicitis, but to indicate briefly how to proceed when the abdomen has been opened by an appendix incision and an intraperitoneal lesion other than appendicitis is found. This section assumes some importance, for we are in the habit of recommending opening the abdomen by a small gridiron incision in cases where an intraperitoneal lesion seems certain but an exact diagnosis cannot be formulated.

Peritonitis is manifest, but the appendix, though obviously inflamed, is not obviously perforated. Remove the appendix and get someone in the theatre to slit up the organ and show you the mucosa. If the appendix is the cause of the peritonitis it will assuredly be more inflamed on the inside than the outside.

From the quantity and the quality of the fluid which escapes when the peritoneum is opened perforated duodenal ulcer is probable. By way of the appendix incision insert a suprapubic drain (which incidentally will enable you to get a good sample of the fluid for your inspection). Close the appendix incision and open the upper abdomen.

Perforated diverticulitis is probable. After having examined the last two feet of ileum for a Meckel's diverticulum (this step can often be omitted if there is a lead to the site of the diverticulum), close the incision and reopen the abdomen by a Battle's incision on the left side. (*See* DIVERTICULITIS, p. 95.)

Thin blood-stained fluid is found. The following conditions are possible causes thereof: (*a*) Streptococcal peritonitis; (*b*) Intestinal obstruction, as by a band; (*c*) Acute pancreatitis; (*d*) Mesenteric thrombosis. Chocolate-coloured fluid is said to be characteristic of volvulus.

Pure blood is found in the general peritoneal cavity. There has been no accident. In the female it is certainly a ruptured ectopic pregnancy. In the male, spontaneous rupture of the spleen.

THE OCHSNER-SHERREN OR DELAYED TREATMENT OF APPENDICITIS

The Ochsner-Sherren treatment can be recommended in many cases of appendicitis of over fifty hours' duration.

The following exceptions are made, and immediate operation is advised :—

1. In the presence of hyperæsthesia. (Other things being equal, the presence of hyperæsthesia indicates that the appendix is still unperforated.)

2. Where there is obvious general peritonitis.

3. In children, especially those under the age of 8 years.

4. Where a purgative has been ingested recently.

5. Where there is uncertainty in diagnosis.

In order to practise the delayed treatment successfully, the surgeon must be a reliable diagnostician. If intraperitoneal lesions normally requiring immediate operation cannot be excluded definitely, it is wiser to operate.

The type of case *par excellence* for the delayed treatment is the patient who gives a typical history of appendicitis and on examination a localized mass is palpable in the right iliac fossa.

The delayed treatment of appendicitis *must* be carried out on the threshold of the operating theatre by the surgeon himself, for at any moment operation may become imperative. The responsibility for delaying operation rests entirely with the operating surgeon, and no other. It is he who is going to perform the operation, and he is at liberty to choose the time he will do it. In a civilized country it should be criminal to attempt this treatment outside a surgical hospital or a correspondingly equipped nursing home with a staff trained in the method. On the other hand, one can picture extenuating circumstances where the risk of attempting this treatment would be less (by reason of these circumstances) than attempting operation—for instance, in a small ship at sea.

Details of the Method. A careful history is recorded, together with a diagram of the physical signs at the time of the first examination. Every effort is made not only to diagnose appendicitis irrefutably, but also to diagnose the *position* of the appendix, whether retrocæcal, in the right iliac fossa, or pelvic. The patient is then placed in the high Fowler's position, the head end of the bed being placed on blocks (*see* FOWLER'S POSITION, p. 56).

Charts.—As a routine the pulse is recorded every two hours in graphic form on a special chart. In cases where anxiety is felt as to the advisability of continuing the treatment, an hourly chart is employed. On several occasions, when the peritonitis has been widespread, I have even had a half-hourly chart prepared through the

night. Temperature is relatively unimportant, and it is recorded
every four hours. Instructions are given to the nurse to record any
vomiting on a separate piece of paper, known as a vomit chart. On
this is entered the time at which the vomitus was ejected, together
with the quantity and character of the fluid.

Diet. Water only is given for four days, or occasionally longer.
This is adhered to very strictly. The amount of plain cold water the
patient may have is unlimited, although he is not encouraged to drink
more than is necessary to satisfy his thirst. In order to prevent
accidents it is well to have a notice over the patient's bed, " Water
only ; no purgatives ". It is very desirable to explain to the patient
that he is going to be starved "in order to prevent the appendix
bursting " is what I tell them. On the fifth day, if the pulse and
temperature are satisfactory and the patient feels hungry, feeding is
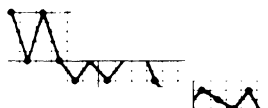
Fig. 84. Two-hourly pulse-chart, showing resolution of a case of
appendicitis under Ochsner-Sherren treatment.

commenced. Small feeds of Benger's food, alternating with a cup
of Bovril are given. On the sixth day custard and jelly are allowed.
After that the diet is increased gradually.

Drugs. All drugs are forbidden. Particularly should it be noted
that no morphine or its derivatives is given.

The Bowels. The bowels are left confined if they are not opened
naturally. On the fourth day a small glycerol enema is given. No
purgatives of any kind are administered until resolution is complete :
that is, until the pulse and temperature have been normal for a week
and pain and physical signs are absent. Then liquid paraffin ʒij
thrice daily is prescribed.

Pain, as opposed to tenderness, is complained of very seldom
after the first night of the treatment. A hot bottle may be given to

the patient to apply to the abdomen; but it is well to repeat that as long as the inflamed appendix remains *in situ* drugs are forbidden, for they may mask those all-important signs which foretell that the delayed treatment is not likely to succeed. Instructions are given for the nurse in charge to watch the patient and report immediately: (1) A rising pulse-rate; (2) Vomiting; (3) Pain; (4) Diarrhœa or the passage of mucus in the stools (pelvic abscess).

A *rising pulse-rate* in the early stages is the most reliable *single* sign that it is dangerous to proceed with the delayed method. If the pulse-rate has increased even ten points in the first four hours, operation is often indicated. I do not feel at all alarmed at a moderate rise in temperature. It quite often indicates that the patient is exhibiting a good reaction to the inflammatory process; it does not necessarily mean that a local abscess is developing, though this, of course, may be the case, and will be revealed by the physical examination. A moderate rise of temperature with a pulse-rate in the eighties or nineties does not foretell failure of the delayed treatment.

Vomiting after the first few hours should always be regarded seriously, and this by itself may be a sufficient indication to abandon delayed treatment.

A patient undergoing delayed treatment should not complain of *pain*, as opposed to tenderness, after the first six hours of treatment. If he does there is usually something wrong, and this is a strong indication for operation. In the few cases in which pain has been the determining factor in advising operation a large thick-walled unperforated appendix has been found. The patient was experiencing appendicular colic.

After a large experience of the Ochsner-Sherren treatment I have nothing but praise for it. Several hundred cases have resolved uneventfully (*Fig.* 84). As in surgical practice one always seems to get ill fortune in batches, it sometimes happens that several cases in a short period of time fail to resolve.

If the delayed treatment fails, and the patient has been starved for some days, the urine should be examined for acetone before the anæsthetic. In any case glucose and saline is prescribed. If acetone is present it is often good practice to perform the operation under spinal anæsthesia.

I have tried to emphasize the possible dangers of this treatment in order that there should be no slackness in its application. The method in itself is life-saving; the chief danger lies in its abuse. Surely this is true of most good things.

In order to strengthen the confidence of those who have not had the advantage of a thorough training in the method I can state with assurance :—

1. Subphrenic abscess is almost unknown, and I have not had a case which could be attributed to the Ochsner-Sherren treatment.

2. Pylephlebitis does not occur. I have had a number of cases of pylephlebitis, but not once has it developed in a patient undergoing delayed treatment (*see* PYLEPHLEBITIS, p. 152).

3. Intestinal obstruction is very much rarer than after immediate operation.

4. The treatment is not a hardship to the patient.

5. In the long-run there is very little wastage of hospital beds. But what is this in the matter of saving a useful life ?

One of the most important duties in a case where the delayed treatment has proved successful is to ensure that the patient has his appendix removed in due course. In former days it was the custom to perform appendicectomy before the patient left hospital. This is, without question, a great mistake. Experience shows that in an average case an interval of two months is necessary for the products of inflammation to resolve completely. Appendicectomy soon after clinical resolution is often a very difficult operation, and the patient, by reason of the starvation, is ill prepared to stand it. If an interval of two months elapses between the time he is fit to be discharged and the operation it will be found that everything has settled down, the patient's general condition will have improved, and the operation will be comparatively easy. It is remarkable how few adhesions are found.

Unfortunately a very real danger creeps in. The patient may fail to appear for his operation. I found that more than 5 per cent of those who had successfully undergone the Ochsner-Sherren treatment failed to return. They were written to and a proportion replied, with varying excuses, the principal being that they had not understood. In 1926 I adopted the following plan. As soon as it is evident that resolution of the disease may be expected confidently, the patient is handed two cards to sign. On each is printed the following words :—

> I realize that I have just been tided over an attack of appendicitis. The surgeon considered that in my case it was safer to defer operation. I fully understand the danger of leaving the appendix, and I agree : (1) To come into hospital on   : (2) To report at the hospital immediately if I have any symptoms before that date.
>
> *Signed*

One card the patient takes away. The other is indexed and serves to remind the staff of the appointment, which except in special cases is made for a date two months after leaving. This method has worked admirably, and frees the surgeon of the responsibility of inadvertently omitting to explain the necessity for eventual operation.

APPENDIX ABSCESS

"Where there is pus you must let it out" is an old and wise surgical axiom. Nevertheless, it is well established that the rule may be broken in the case of small and moderate-sized appendix abscesses, for these cases often do exceptionally well under delayed treatment.

The lump, which no doubt is in part made up of inflamed omentum, but in most instances contains at least some pus, gradually gets smaller and smaller with starvation and rest and finally disappears. When the time comes for the appendix to be removed one often marvels at the freedom from adhesions ; perhaps there are a few dried-up pieces of leathery substance stuck upon the appendix or the juxta-appendicular structures, but this is all that remains of what was once

Fig. 85.—Patient undergoing the Ochsner-Sherren treatment for appendix abscess. The extent of the lump has been marked on the skin.

an undoubted abscess giving rise to a lump, say, the size of a cricket ball. To those familiar with the delayed treatment such a phenomenon is commonplace.

We will assume that the patient has been admitted with appendicitis of several days' duration, and a lump is present in the right iliac fossa

The Ochsner-Sherren treatment is carried out in exactly the same way as has just been described. The periphery of the lump is outlined on the skin and each day the lump is examined (*Fig.* 85). A rectal examination is performed every third day, or more often if the abscess

has invaded the pelvis. Pelvic abscess will presently be dealt with separately.

It must again be emphasized that the delayed treatment must be carried out by the surgeon himself on the threshold of the operating theatre.

G. P., age 11, whilst undergoing the Ochsner-Sherren treatment for appendix abscess appeared to be going on well, although the size of the abscess was not decreasing. On the fifth day he suddenly collapsed, and showed signs of general peritonitis. Within fifteen minutes gas and oxygen was administered and drainage was instituted both suprapubically and locally. His condition was critical for several days, but he recovered, and six months later appendicectomy was performed uneventfully.

This is a most exceptional complication; it is indeed the only example of its kind that I have encountered, but it illustrates forcibly that the Ochsner-Sherren treatment must be carried out on the threshold of the operating theatre.

Indications that the Abscess must be Drained.—

1. The lump is not getting smaller after the fifth day, or alternatively is getting larger before this time.

2. The lump is visible when the abdomen is viewed tangentially.

3. The temperature is swinging above 100° F. on several successive days. A moderate intermittent rise in temperature is not a contra-indication to delayed treatment.

4. Childhood.

5. Fluctuation can be elicited—a rare occurrence which indicates that the abscess has already been left too long.

6. Pelvic abscess. It is difficult to estimate the size of an abscess which has invaded the pelvis. (*See* PELVIC ABSCESS, p. 89.)

If delayed treatment has been tried, as I feel convinced it should be, the number of appendix abscesses which need drainage will be comparatively small. Those that do require evacuation of pus will be frank abscesses, and the technique may be reduced to the simplest character, for the question of removing the appendix at the time of the evacuation of the pus never arises. This, no doubt, helps to account for the very small mortality of appendix abscess treated on the above lines. We are spared the possibility of turning a localized abscess into general peritonitis, a tragedy which I have witnessed more than once under the older régime of immediate operation.

Draining an Appendix Abscess situated in the Right Iliac Fossa.—

Anæsthetic.— Gas and oxygen or evipan anæsthesia usually suffices.

Technique.— The swelling is palpated under the anæsthetic. A point is chosen about the centre of the swelling, but rather nearer the lateral than the medial aspect. A small incision is made ; small because it is naturally very prone to become infected, and there will

be less of it to break down. The incision I use for the purpose is at right angles to the usual gridiron incision (*Fig.* 86). The incision is deepened, all layers being divided in the same axis as the skin.

Two advantages are claimed for departing from our usual practice of splitting the muscle layers. Firstly, an incision of one and a half inches will be found to be adequate if the internal oblique is divided instead of being split; secondly, drainage is direct. There is no valve-like action of the criss-cross to interfere with the exit of pus and the re-insertion of a shorter tube.

The peritoneum is opened in the customary manner after it has been rendered accessible by suitable retraction. More often than not, opening the peritoneum does not open the abscess. Every care should be taken to avoid breaking adhesions unnecessarily, especially on the medial side. The extremity of a length of gauze is packed gently into the *mesial* part of the wound. The index finger is passed into the wound and very, very gently burrows laterally and backwards. In the case of a large abscess it is hardly a moment before the finger is felt to enter a large cavity. The finger is still kept *in situ* and acts as a bung to the flow of stinking pus until a tube can be passed into the abscess cavity. The tube is fixed by a single stitch, which is often the only one necessary to approximate the wound about the tube. Pus now flows through the tube and may be collected in a receptacle. As the abscess cavity collapses, the flow becomes more and more blood-stained. This is not a cause for alarm. The abscess cavity is lined by granulation tissue which oozes freely.

Fig. 86.— Incision for appendix abscess. The advantag   s to this skin incision (at r   s to the usual one for appe   y) is that the scar forms a   ark that the appendix has

After the patient has been returned to bed he is again placed in the high Fowler's position and a pillow placed under his left loin in order to keep him on his right side and thus invoke the aid of gravity. After the first forty-eight hours the tube is turned and shortened only. Usually it is omitted altogether on the sixth day. There are seldom any complications if a frank abscess has been drained.

The patient should be given a card to sign bearing the agreement to return for appendicectomy (*see* p. 85). He should be examined at monthly intervals. It is most inadvisable to attempt the second operation (appendicectomy) until at least *four* months later, which

may be extended to six months, unless of course symptoms develop in the meantime.

Dangers and Difficulties.—

1. One may have to burrow for some little distance before a retrocæcal abscess is opened. This burrowing must be done very gently. In certain cases it may be advisable to place a tube through a counter-incision in the flank, in which case the original incision is closed about a corrugated rubber drain.

2. Owing to some mischance, such as fatness of the abdominal wall masking physical signs, or undue anxiety on the part of the surgeon, cases occasionally come to operation where the abscess is resolving. In such cases, on opening the peritoneum a mass as hard as a rock may be felt. If this lump has been present for some time and carcinoma is suspected, the incision must be enlarged. My advice in the case of a hard, fixed, rock-like mass is to leave it alone, sew up the abdominal wall with the least possible intra-abdominal disturbance, and return to masterly inactivity. In five instances where this has been done resolution has proceeded evenly, in spite of the untimely incision. In three of these cases the abdomen was closed without drainage. In each of the four cases appendicectomy was undertaken successfully in six months' time. On no account tear up the indurated tissues with the finger in an endeavour to find central pus. One is almost certain to prise open the cæcum and a fæcal fistula will be the result, which often proves a grave complication.

Difficulties in Diagnosis.—Twice I have mistaken a ballooned cæcum following on large-gut obstruction for an appendix abscess. In each case, because of vomiting, the patient was submitted to operation after twenty-four hours of delayed treatment, and no harm resulted. Twice twisted ovarian cysts were mistaken, and again pain and vomiting brought the cases to operation on the second day, with recovery. At least once I have not been able to make up my mind between perforated diverticulitis and appendix abscess, and I have waited, with fatal results. If perforated diverticulitis enters the clinical picture this is sufficient indication for an immediate exploration.

DRAINAGE OF A PELVIC ABSCESS PER RECTUM

The pelvic abscess to which I refer is one which is seen in surgical, as opposed to gynæcological, practice, and usually, but not necessarily, arises as a complication of acute appendicitis. As is well known, pus can accumulate in the pelvis (*Fig.* 87) without serious constitutional disturbance : it is therefore not surprising that these abscesses sometimes attain large proportions before being recognized. The most characteristic symptoms to which they give rise are diarrhœa and the

passage of mucus. The latter is of cardinal diagnostic importance ;
it is no exaggeration to say that the passage of mucus occurring for
the first time in a patient who has, or has recently had, an attack of
acute appendicitis is pathognomonic of pelvic abscess. Rectal exam-
ination reveals a bulging of the anterior rectal wall, which, when the
abscess is 'ripe', becomes softly cystic. It is inaccurate to say that
it fluctuates, unless fluctuation can be elicited between it and the
anterior abdominal wall. Fluctuation cannot be tested with one
finger.

Left to nature, a proportion of these abscesses burst into the
rectum, after which the patient
nearly always recovers.
Deliberate opening into the
rectum should be contem-
plated when the swelling is
quite soft. *Blind rectal drain-
age should be reserved for those
cases where the history, the free
discharge of mucus, the softly
cystic swelling, and complete
absence of abdominal rigidity,
make the diagnosis of a localized
abscess pointing in the rectum
absolutely undeniable.* If there
is the slightest doubt—and it
is sometimes difficult, partic-
ularly in post-operative cases,
to be quite certain—lapar-
otomy should be performed ;
but, having opened the abdo-
men in the doubtful case,
having ascertained that there
is no obstruction present,
having felt a mass occupying
the true pelvis, and having

Fig. 87.— A pelvic abscess about to
into the rectum.

seen that that mass is walled off completely from the general peri-
toneal cavity, I submit that to close the abdomen immediately and
then to drain the abscess into the rectum is a practice which fulfils
the highest object of surgery. To choose the alternative (suprapubic)
route for draining the pus seems most undesirable, if not actually
mischievous, for of necessity Nature's barriers must be broken down
and the general peritoneal cavity exposed to the peril of a spreading
infection.

Technique.—The first thing to do is to empty the bladder with a

catheter immediately prior to the anæsthetic. Low spinal anæsthesia is sufficient, or evipan may be used. The patient is placed in an exaggerated lithotomy position. The small end of a Sim's duck-billed vaginal speculum, which answers the purpose admirably, is introduced into the rectum (*Fig.* 88). The passage of some mucus when the speculum has been inserted is very characteristic. I use an ordinary long hæmostat to penetrate the rectal wall. This is done, not by a sudden jab, but by even pressure. As soon as the abscess is entered

BULGING ANTERIOR RECTAL WALL

MUCUS
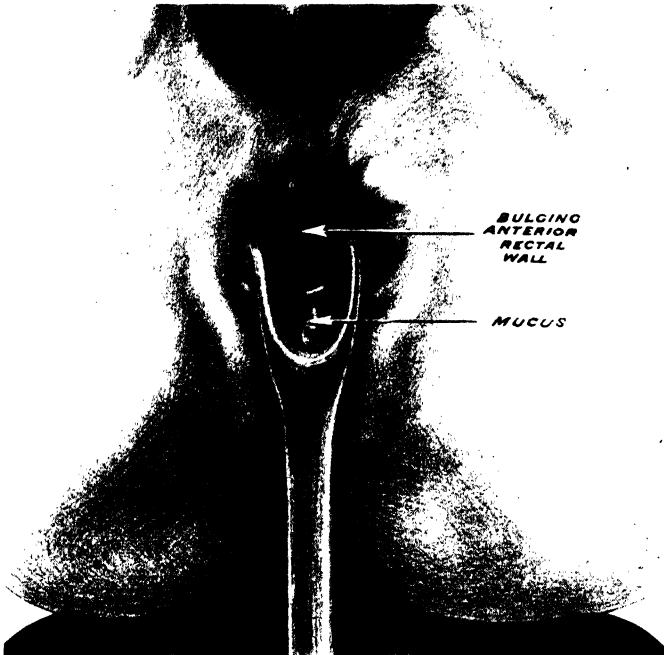
pus streams down the speculum. A suitable piece of drainage tube is inserted into the abscess cavity and anchored to the anal verge by a single stitch. The tube is removed on the fourth day. As a rule the patient previously had diarrhœa; once the abscess is opened this ceases and if possible the bowels should remain confined until the tube is removed. The patient is nursed in high Fowler's position for a week. *Fig.* 89 shows the temperature chart of a case treated in this way. I have used this method in a large number of cases, and never with regret.

In the case of an adult female, particularly a married woman, posterior colpotomy (p. 295) is a good alternative, perhaps, even a better method than rectal drainage.
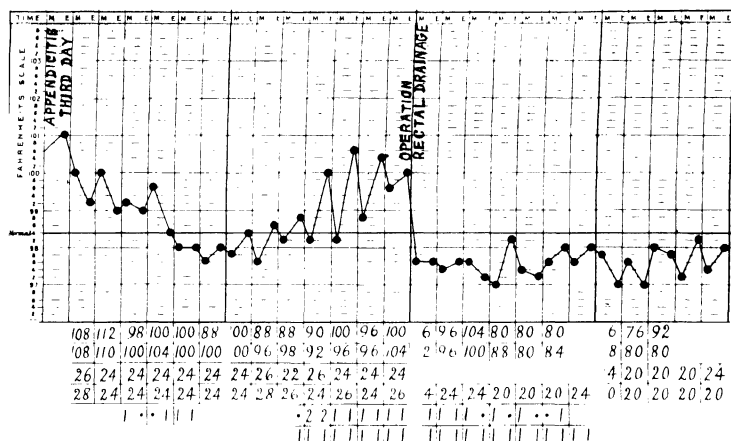
Fig. 89.—The temperature chart of a patient who developed a pelvic abscess which was drained per rectum.

ACUTE APPENDICITIS WITH GRAVE GENERAL PERITONITIS
(*See also Chapter VI*)

Whether the delayed treatment is going to be employed or not, there is not a shadow of a doubt that it is better to delay operation for two or three hours in order to get the patient into the best possible condition (*see* p. 60). Usually, as a result of this treatment, some indication of improvement is manifest. We are now faced with a problem requiring considerable judgement.

It will be recalled that Ochsner himself first framed his method for cases of spreading peritonitis. There is plenty of evidence that certain cases of this type respond to the method. The treatment aids nature in transforming the general peritonitis into a localized infra-umbilical or pelvic collection of pus, which can then be treated safely by simple drainage.

Experience teaches us that simple drainage without removal of the appendix *before localization of the peritonitis has occurred* rarely saves the patient's life. Indeed, in many instances it appears to hasten the end. On the other hand in most cases the *expeditious* removal of the appendix together with suprapubic drainage and cæcostomy or enterostomy (p. 62), is, I believe, the best line of treatment in perforated appendicitis with general peritonitis, but the operation must be expeditious and the anæsthesia as perfect as possible. Should

the operation prove to be difficult, necessitating considerable intra-abdominal manipulations, or if the attempt to remove the appendix has to be abandoned in favour of simple drainage, death usually follows. Under these circumstances one must be prepared to state that such a case might have been saved by the delayed method.

In the light of the above remarks it is at least necessary for the surgeon to pause for a moment before advising immediate operation, and ask himself a question :—

Is it likely that this appendix can be delivered without undue difficulty ?

No one can answer this question with assurance, but one can say this much : *If the disease has been present for more than sixty hours it is practically certain that the appendix will be matted to neighbouring structures.*

Under such circumstances perseverance with the delayed method in the hope of localization of the infection offers the patient his best chance. There are two notable exceptions to this rule :—

1. *In childhood and early adolescence.* Localization of a general peritoneal infection does not occur often enough in early life to warrant a trial of the delayed method unless the circumstances are extenuating.

2. *If there is good reason to believe that the general peritonitis is due to the recent bursting of an appendix abscess.* Here simple drainage is a life-saving measure.

I have tried to show that there must be adequate reasons for adopting a particular method. If those reasons dictate delay in operating, then the surgeon must be courageous, for in this instance it requires more courage *not* to operate.

APPENDICITIS IN PREGNANCY

" Ignore the pregnancy. Appendicitis is a serious lesion, and as such should be treated on its merits."—(*Cuthbert Lockyer.*)

The chief difficulty in dealing with appendicitis complicated by pregnancy is to establish the diagnosis. Pyelitis of pregnancy, vomiting of pregnancy, and twisted ovarian cyst are the conditions with which the symptoms are most likely to be confused. When it is of paramount importance to exclude pyelitis, the microscopical examination of specimens of urine obtained from the right ureter by cystoscopy and catheterization will sometimes settle a very important and urgent question. The fact must be continually before the surgeon that acute appendicitis is a not infrequent and a supremely important complication of pregnancy, and if only the diagnosis can be established within forty-eight hours from the onset appendicectomy can be undertaken safely. When the intra-abdominal manipulations can be reduced to a minimum the pregnancy is not necessarily interfered with. Abortion

occurs in about 10 per cent when operation has to be undertaken during the first three months of pregnancy. After the third month the liability to abort becomes increasingly less. If peritonitis has set in, abortion is the rule even in advanced pregnancy. Once I removed a gangrenous perforated appendix at the twenty-fourth hour in a woman six months pregnant, and she miscarried shortly afterwards, but recovered.

The fact that the patient is pregnant makes no difference in selecting suitable cases for the Ochsner-Sherren treatment. My experience in this direction has been small but entirely satisfactory ; the most notable example was a woman of 28, four months pregnant, with a large appendix abscess. She was seen first on the seventh day, and the pulse was 112. On the next day the pulse was 104, and after this it remained between 75 and 80. Slowly the abscess resolved completely.

COMPLICATIONS OF ACUTE APPENDICITIS

1. General peritonitis (p. 60).
2. Paralytic ileus (p. 312).
3. Intestinal obstruction, after operation for appendicitis (p. 229).
4. Internal fæcal fistula (p. 66).
5. External fæcal fistula (p. 317).
6. Subphrenic abscess (p. 156).
7. Pylephlebitis (p. 152).
8. Post-operative pneumonia (p. 314).
9. Pulmonary embolus (p. 311, 444).
10. Femoral and iliac thrombosis (p. 311).
11. Septicæmia (p. 685).

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CHAPTER VIII

SOME CONDITIONS SIMULATING APPENDICITIS

PERFORATED DIVERTICULITIS OF THE COLON

THE perforated diverticulum may be situated in any portion of the large intestine but the incidence in the pelvic colon by far exceeds that met with in all the remainder put together.

A perforation of the colon provides an avenue for fæces and flatus to pass into the peritoneal cavity ; consequently a most virulent peritonitis ensues rapidly. The diagnosis is often difficult and the patient usually obese and elderly, a combination of circumstances which makes perforated diverticulitis one of the most lethal of the intra-abdominal catastrophes.

1. **Perforated Diverticulitis with General or Pelvic Peritonitis.**— It goes without saying that the peritoneal cavity must be drained, and in desperate cases drainage is all that can be accomplished. Treatment limited to simple drainage seldom saves the patient's life.

Closure of the Perforation.— To close the perforation is an obvious first principle, but it is easier said than done. Doubtless closure could be carried out more frequently than is the case were it not that the abdomen is usually opened on the right side, whereas the lesion is nearly always on the left. Here is a lesson. If it is possible to make a correct pre-operative diagnosis, open the left lower abdomen by an incision comparable to a Battle's incision. If necessary, carry the incision right down to the pubic arch, and after packing off the field place the patient in the semi-Trendelenburg position. If the abdomen has been opened on the right, and the patient's condition is fair, close the original incision and reopen the abdomen over the leaking segment. With proper exposure the perforation can often be closed or patched with an appendix epiploica if the omentum is not available. At the very worst a tube or de Pezzer catheter can be fixed in the opening and brought out on the surface.

The chief hope in reducing the present appalling mortality of perforated diverticulitis with peritonitis lies in more perforations being found and closed. Adequate exposure will be of assistance in this direction.

Colostomy.— Unless the perforation has been closed satisfactorily and the disease is found to be comparatively localized, colostomy should be performed. Of necessity this colostomy must be carried out at some distance above the perforation, for the affected segment

is only too often fixed and matted to neighbouring structures, rendering its elevation above the fat abdominal wall quite impracticable. As a general rule *transverse* colostomy will be the quickest and best method.

Paul's Operation (*see* p. 207). In rare instances the pelvic colon will be mobile; nearly always it is abnormally fixed. If the diseased segment is sufficiently mobile the indication is clear—perform Paul's operation; bring the loop containing the perforation right out on the surface and fix it there, as was done in the following case of acute diverticulitis. A taxi driver stated that fourteen hours previously he had been seized with acute abdominal pain, which had awakened him in the early morning. His temperature was 99 and his pulse normal. On abdominal examination the only physical sign was diffuse tenderness, most marked in the hypogastrium. *Per rectum* a hard lump could be felt in the recto-vesical pouch. When I touched this the patient cried out in pain and said it felt like a red-hot dagger being thrust into his navel. Pelvic appendicitis was diagnosed. On opening the abdomen the pelvic colon, which was turgid and bright red, was found in the rectovesical pouch and the nature of the tender lump was clear. This portion of the colon was delivered on to the surface and later excised by Paul's method, with recovery.

2. Perforated Diverticulitis with Localized Abscess.—If there is reason to suspect that a localized abscess is connected with a perforated diverticulum of the colon, expectant treatment, in the hope that the abscess will resolve, should not be attempted. An appendix abscess of reasonable size often resolves completely, but a localized abscess connected with a perforated diverticulum often bursts either into the peritoneum or into the bladder. Operation is therefore indicated at the earliest possible moment.

Assuming that the abscess is connected with the pelvic colon, the usual site of diverticulitis, an incision similar to a Battle's incision, but on the left side, is once more preferable. Referring to this condition Lockhart Mummery writes : " The pelvic colon should be freed if possible by gentle manipulation while the main abdominal cavity is well protected by large intra-abdominal swabs, so placed as to localize as much as possible the contamination of the peritoneal cavity which may occur. The involved part of the pelvic colon should be lifted up if it can be freed, and drawn well over into the left iliac fossa, and the abscess cavity drained with tube or tubes. If the omentum is large enough it should be drawn down and stitched all round the damaged portion of the colon so as to seal it off and at the same time prevent the small intestine from subsequently becoming adherent to it. The wrapped-up damaged portion of colon should be fixed with a few catgut sutures well into the left iliac

fossa and away from the true pelvis, as if subsequent abscess formation should occur it will do less harm in this situation and will be much more accessible. Patients treated in this way have been saved a colostomy and in course of time the inflammatory mischief has entirely cleared up."

ACUTE INFLAMMATION OF MECKEL'S DIVERTICULUM

In contradistinction to diverticulitis of the colon, disease of Meckel's diverticulum (*Fig. 90*) is usually seen in children or young subjects. This condition gives rise to exactly the same signs as acute appendicitis. At operation, particularly in the young, after the appendix has been examined and found blameless, it is an excellent practice to at once expose by gentle traction the last two feet of the ileum. If an inflamed Meckel's diverticulum is found, it is amputated by crushing and embedding its base, in much the same way as the vermiform appendix is removed.
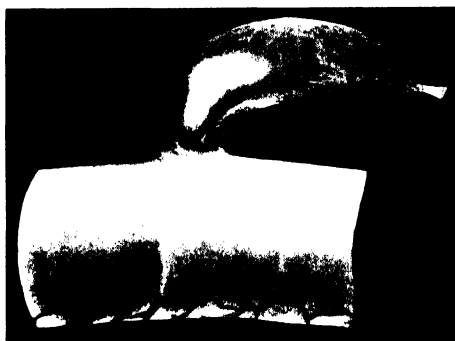
Fig. 90. Acute Meckelian diverticulitis (*Eisendrath*).

SUPPURATING DEEP ILIAC GLANDS

Suppurating deep iliac glands often cause considerable difficulty in diagnosis. When on the right side the diagnosis may be confused with appendicitis.

Fig. 91.—Incision for draining suppurating deep iliac glands.

A boy of $7\frac{1}{2}$ was brought to hospital with pain in his stomach, of one week's duration. The right thigh was flexed to an angle of 30° (psoas spasm), and an indurated swelling was present above the outer half of Poupart's ligament. On further examination a small infected scab was found over the right shin. The patient had not vomited : moreover the inguinal glands on the right were palpable, but not so on the left. These points made the diagnosis of suppurating deep iliac glands tolerably certain, and he was treated with hot fomentations for four days. At the end of this time fluctuation could be elicited, and the abscess was opened as described below. The psoas spasm soon passed off and the wound healed in ten days.

When a diagnosis of deep iliac glands can be made there is no occasion to operate for a few days. It is best to wait until an abscess forms. The incision should be made just above the anterior superior iliac spine (*Fig.* 91), and care be taken that the peritoneum is not opened.

TORSION OF THE GREAT OMENTUM

Torsion of the great omentum (*Fig.* 92) is very rarely correctly diagnosed It is usually mistaken for appendicitis with somewhat abnormal symptoms. The omentum may go on to complete gangrene and give rise to general peritonitis.

F. W., age 28, gave a history of five days' general abdominal pain. Twenty-four hours before admission he gave up work and went to bed. He had not vomited, and there was no history of a previous attack. The pulse and temperature were normal.

On examination, he pointed to the right iliac fossa as the site of the most acute pain. There was very marked general abdominal tenderness, but no rigidity. An ill-defined lump could be palpated in the right iliac fossa. A diagnosis of unperforated appendicitis was made.

Under the anæsthetic the lump could be clearly demonstrated, and was movable. It was thought that it was probably an acute appendix wrapped in omentum. The abdomen was opened by a Battle's incision, and a small quantity of blood-stained fluid escaped. The lump was found to be a piece of great omentum about the size of a tangerine orange, the neck of which was pedunculated and obviously twisted. The mass, on being removed, was found to be quite gangrenous. No other abnormality was found. The appendix was removed, and appeared quite normal. Recovery ensued.

Fig. 92. Torsion of the omentum.
(*Archibald Ronald.*)

Cowell, in an exhaustive paper on this subject, found that the mortality was 5·5 per cent. An important point to be remembered is that torsion of the great omentum is one of the causes of blood-stained fluid in the peritoneal cavity. Untwisting may be attempted, but it is usually impossible. In any case the base should be ligatured securely and the mass removed.

TORSION OF AN APPENDIX EPIPLOICA

I have come across several cases of this condition, which in my experience is more common than torsion of the omentum. The tenderness over the twisted appendage is acute, but there is little abdominal rigidity. A correct pre-operative diagnosis is improbable. The treatment is simplicity itself, a ligature is applied to the base of the appendage, which is snipped off with scissors.

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CHAPTER IX

THE STOMACH

ASPIRATING THE CONTENTS OF THE STOMACH

WASHING out the stomach of a desperately ill but fully conscious patient ranks high among the most distasteful tasks in surgery; it is only natural to shrink from adding to the discomfort of the patient. Misdirected compassion, or fear of still further upsetting a patient who is already in a critical condition, may be determining factors in withholding the stomach tube in cases where it is indicated strongly—a form of conservatism which is often the antithesis of good judgement. In those conditions where emptying the stomach may prove a life-saving measure the contents of the organ are known to be of a watery consistency; acute dilatation of the stomach, intestinal obstruction, and vomiting after gastrojejunostomy are but a few of such conditions.
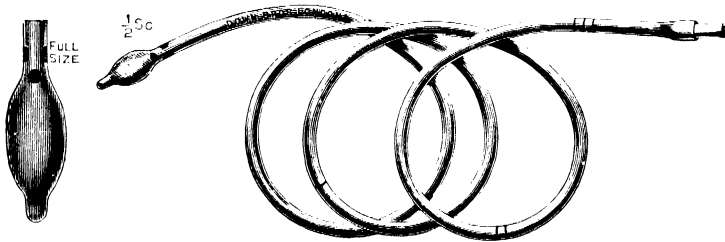
Fig. 93.—Ryle's small stomach tube.

The question which arises is, Why employ a large calibre tube to evacuate a watery fluid? Ryle's small stomach tube (*Fig.* 93), connected to an aspirating syringe, opens up a new field in urgent gastric therapeutics. A *small* stomach tube can be swallowed without overwhelming discomfort and without shock. In the few patients who find that they cannot swallow the tube a little 10 per cent cocaine sprayed on the pharynx will enable them to do so. Once the tube is in position the stomach contents can be aspirated with a syringe (*Fig.* 94). A bladder syringe answers the purpose, but the well-fitting Janet's 6-oz. glass syringe with metal plunger makes for a perfected technique. After the contents have been aspirated the organ may be washed out with boiled water, or anything else which is thought desirable. After using this technique, no one who has had experience with the large red rubber tube, funnel, jug, and mackintosh apron would wish to return to them.

Having once gained familiarity with the method, one finds increasing fields of usefulness for gastric aspiration. Not only does the need for jejunostomy grow less, but there will be found occasions when the method may be employed as an aid to urgent diagnosis.

Fig. 94. Aspirating the contents of the stomach.

CONTINUOUS DRAINAGE OF THE STOMACH

After cocainizing the throat and one side of the nose a duodenal tube is introduced into the stomach in the following manner. It is passed down the nostril until the end appears in the nasopharynx. A mouth-gag is introduced and the tube is grasped with

Fig. 95. Continuous drainage of the stomach via the nose. Inset, Jutte's tube. (After C. M. Smyth.)

a long hæmostat, or other suitable forceps. Using the forceps at the back of the throat, and pushing the tube gently down the nose at the same time, the tube is manipulated down the œsophagus (*Fig. 95*). The tube is held in place by strapping it to the cheek with adhesive plaster.

Once syphonage has been established by a syringe the free end of the tube can be allowed to lie in a bottle. With the tube in the nose the patient can drink water without producing vomiting, for if the stomach rejects the fluid it can be regurgitated through the tube. The period over which benefit can be expected from continuous gastric drainage is about forty-eight hours. In most cases it is advisable to combine this form of therapeusis with venoclysis.

ACUTE DILATATION OF THE STOMACH

It is of paramount importance to recognize this condition promptly. Practically all unrecognized cases die. The enormous effortless vomits soon becoming the colour and consistency of the storm water of a peat-laden stream; the collapse, and perhaps the physical signs
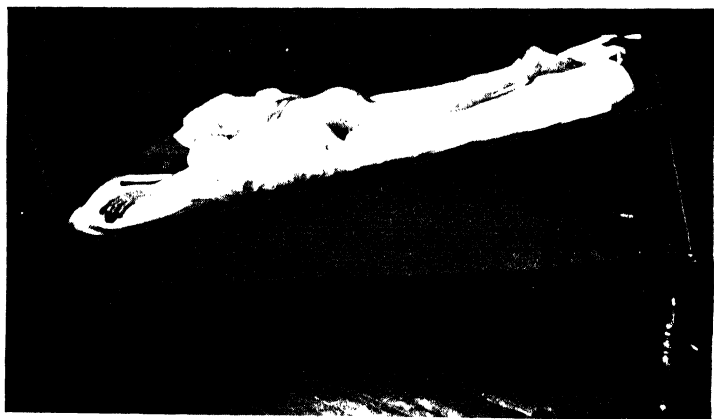
Fig. 96. Acute dilatation of the stomach. The correct position to be adopted. A small stomach tube is used and the contents of the stomach aspirated.

of a dilated stomach, should render the clinical picture clear. Acute dilatation is a rarity which can occur after any operation, and indeed after no operation at all; it is hardly surprising that sometimes the diagnosis is missed. Two cases of acute dilatation under my care occurred after putting up a fractured femur. A third followed gastroduodenostomy for a duodenal ulcer (which had previously perforated) in a man with profound gastroptosis.

The treatment is simple, but it must be carried out promptly. If possible, the patient should swallow the end of a Ryle's stomach tube; if he is very collapsed this may be deferred for the time being. *The patient is then turned over on to his face.* A pillow is placed under the pelvis. The foot of the bed is raised on blocks. The correct position is illustrated in *Fig. 96.* As soon as the position is satisfactory, large

quantities of saline are administered, either rectally or intravenously.
Usually several pints of fluid are necessary, for the patient has lost a
prodigious amount of fluid. One dose of pituitrin may be given with
advantage. As soon as the stomach tube can be got into position,
aspiration and irrigation of the stomach are commenced. Aspiration
is continued until the stomach is empty, and the manœuvre repeated
at intervals of a quarter of an hour so long as the characteristic fluid
continues to be withdrawn. During the intervals the tube is closed
with a clip (*Fig.* 97). The tube should be left *in situ* for at least forty-
eight hours. When the pulse improves, the patient may have morphia.
Instructions are given to those in attendance on the case to place a
clove-hitch around each ankle and to fasten them to the end of the
bed if the patient tends to slip down.

The essential thing is to get the patient on to his face as quickly
as possible. Any other ills are of secondary importance. For instance,
if a fractured femur has been put
up, all apparatus must be removed
and some simple contrivance, such
as a long Liston's splint, applied.

After conservative operations
upon the stomach there may be the
greatest difficulty in deciding whether
the case is one of acute dilatation
or high obstruction. If the large
vomits, poor pulse, and sudden onset
are the reasons for this doubt, the
safer procedure is to assume the
former diagnosis, at any rate tempo-
rarily, and to start treatment by the
methods indicated already.

In an instructive paper, W. Doolin
has shown the mortality attending
various methods of treatment of acute
dilatation of the stomach : —

Fig. 97. —Acute dilatation f the
stomach. The stomach has been
aspirated and irrigated, and the tube
situ fo further aspiration.

Expectant treatment	.. ..	93 per cent
Operation (gastrostomy, gastro-entero-		
stomy, etc.) ..	.. ..	72 ..
Lavage	.. ..	50 ..
Lavage plus posture	.. ..	

PERFORATED GASTRIC OR DUODENAL ULCER

The diagnosis of perforated gastric ulcer has been made. Once a
diagnosis has been made and confirmed by the surgeon who is about
to operate, morphia can be administered, but permission for operation

should always be obtained in writing before the drug is given. The relief morphia affords may be followed by the refusal or delay of the patient to submit to treatment. Morphia helps in several ways. It saves the patient at least twenty minutes' agony; it allows the abdomen to be shaved and prepared before the anæsthetic; above all it means less anæsthetic and more relaxation, important factors when dealing with muscular men.

Combating Shock.—When shock is much in evidence it is advisable to delay operation for half an hour. During this interval warmth is applied to the body and continuous intravenous saline administered. The patient is taken to the theatre with the intravenous saline running into a vein, and venoclysis is continued during and after the operation.

The Anæsthetic.—It should be realized that an operation for perforated peptic ulcer can be conducted mainly, and often entirely, under local anæsthesia. Doubtless the general mortality of the condition could be lowered if more attention was paid to this point. There must be adequate pre-operative medication; for a strong man $\frac{1}{3}$ gr. of morphia or hyoscine compound B is given. One per cent novocain is infiltrated into the abdominal wall in the middle line and on either side into the rectus sheath. When the peritoneum has been reached a little general anæsthetic is often desirable. Should the anæsthetist be skilled particularly in gas and oxygen this can be used; if not my own preference is for a light chloroform anæsthesia. Providing the operator is gentle, one needs only a light narcosis similar to that used in childbirth. When suprapubic drainage is indicated local infiltration is made above the pubis.

The Incision.— The mid-line incision is undoubtedly *the* incision for emergency operations upon the stomach and duodenum. For a considerable time now we have used this method of approach in dealing with urgent cases, in preference to the right paramedian, for reasons which have been stated already (*see* p. 36). To commence with, the incision need not be more than three inches in length. If more room is required it can be enlarged upwards or downwards rapidly. Towels are clipped to the sides of the wound, but they are not fixed to the extremities of the incision until it is ascertained that this is of sufficient length to permit of the operation being performed comfortably, a little precaution which saves several moments of unclipping and clipping the towels.

The Search for the Perforation.—Directly the abdomen is opened, unless the perforation is a very small one, gastric fluid begins to gush out with each movement of respiration. It is rather unusual for gas to escape, which is consistent with the pre-operative finding that

diminution of liver dullness is a most inconstant sign in perforated gastroduodenal ulcer. When sufficient fluid has been mopped up to enable the anterior surface of the stomach to be seen clearly, the stomach near the greater curvature is grasped in the right hand with a large swab or an abdominal pad. The left hand contains a swab, and by wiping the stomach here and there the perforation is sought. Naturally it is best to commence looking for the perforation where the fluid is welling up most plentifully. However, one trap must be borne in mind. When an ulcer perforates into the lesser sac, the fluid pours out of the foramen of Winslow, and makes one think that it is the duodenum which is perforated. *In eight cases out of ten the perforation is located easily (Fig.* 98). When this is not the case the following plan is bound to lead to its discovery.

Put a retractor in the right side of the wound, and hand it to the assistant. By swabbing and retracting the stomach, the whole of the first and second parts of the duodenum are inspected. A case in which the perforation was difficult to find was soon demonstrated at the junction of the second and third parts of the duodenum, a most unusual situation, by this method. If this search is not productive, pass the fingers along the lesser curvature, right up to the œsophageal orifice. There is hardly ever any difficulty in recognizing immediately the massive induration around the edges of a perforated *gastric* ulcer. If the perforation is high on the lesser curve, the incision will usually

Fig. 98. Method of holding the stomach when searching for and closing a perforated peptic ulcer.

have to be extended to the xiphisternum before adequate exposure can be obtained. If the search along the lesser curvature is fruitless, a hole is made in the omentum between the stomach and the colon, and the lesser sac opened, which permits the back of the stomach to be examined. Should the lesser sac be filled with gastric fluid, the perforation will be found somewhere on the posterior surface of the stomach.

Closing the Perforation.—The hole in the stomach having been found, retractors and traction upon the stomach are so arranged as to bring the perforation into the best possible view. This position is maintained by the assistant. It is often advisable to pack a gauze strip under the edge of the wound, in order further to aid the exposure by keeping away the transverse colon.

The best method of closure is to use interrupted catgut sutures, Nos. 1 or 2, on a medium-sized curved round-bodied needle. The first suture is placed a little distance from the perforation. It takes a big bite of the stomach wall, in order to prevent cutting out (*Fig.* 99), which is very prone to occur in these œdematous tissues. This suture is the key to the situation, and as soon as it has been tied and it has been ascertained that it will hold, it can be used as a very efficient retractor. The next interrupted suture is passed in the same way and tied, and so on, until the perforation is closed.
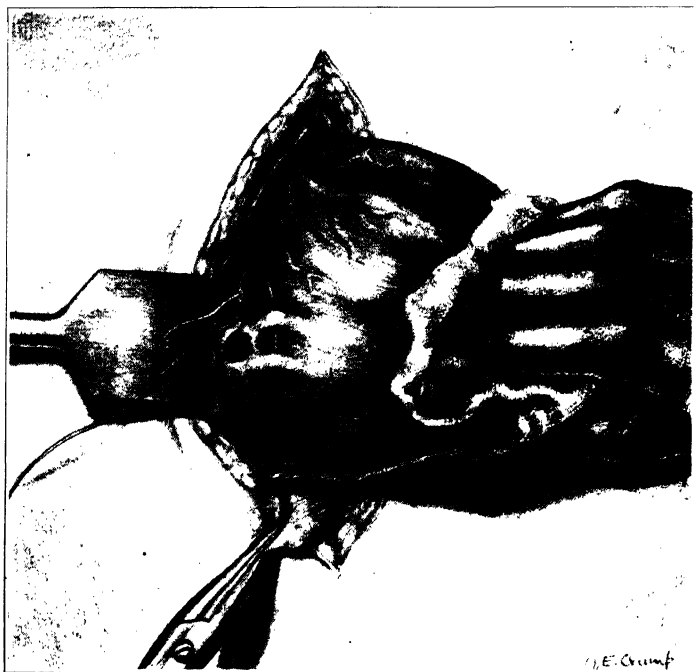
Fig. 99. —Closing the perforation in perforated gastric ulcer.   Tl

When it appears that the perforation is tightly closed, all the sutures are cut short except the first and last. These are retained in order that the suture line may be examined ; if it passes inspection, a tag of neighbouring omentum is brought over to reinforce it. The closure of the perforation is completed. Suppose on inspecting the suture line it is not altogether satisfactory, which is likely to be the case in large irregular perforations, particularly when one or two sutures initially cut out, then take a Watson Cheyne probe, and go over the suspicious area with a view to finding a crevice (*Fig.* 100).

When the perforation is situated in the duodenum, one can usually find a convenient flap of omentum to bring down to cover in and reinforce the suture line.

The Free Omental Graft: Patching the Perforation.— In the exceptional case, especially lesser-curve ulcers, where the closure of the perforation is unsatisfactory, the use of free omental graft to reinforce the suture line is indicated. Spread the edge of the great omentum upon the towel covering the abdomen. Select a portion, and place long hæmostats as shown in *Fig.* 101. In this way a square about the size of four postage stamps is removed for transfer. The square of omentum should be kept in between the hæmostats, which function as a spreader, until it has been sutured into place. If this is not done, the square will tend to curl up, and bungling, with its concomitant loss of time, will assuredly follow.

ulcer has being used to see if the suture line

V. P. Fontana reinforces the suture line with the falciform and round ligaments of the liver. When the round ligament has been freed from the abdominal wall inferiorly it forms with its associated falciform ligament a convenient patch for many perforations, particularly those on the lesser curvature.
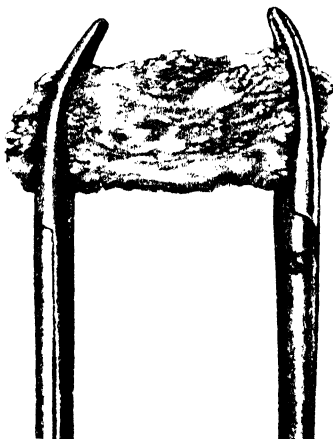
Fig. 101.—Free omental graft. Method of transferring the graft.

The Omental Plug.—When the size of the perforation, thickness, and friability of callus surrounding it make the perforation superlatively difficult to close, an omental plug should be employed. A free omental graft of a suitable size is taken and fashioned

into an hour-glass shape, one half of which is pushed through the perforation. The plug is reinforced by another omental graft, sutured around the ulcer area about one inch from the margin of induration.

Looking for a Second Perforation.—It is worth while making a practice of looking for a second perforation; a few seconds will suffice. Simultaneous perforation of two ulcers has been reported, and we have seen at necropsy a case where one perforated ulcer had been closed satisfactorily and another perforation had been overlooked.

The Question of Cleansing the Peritoneum.—For some time we have given up all attempts at swabbing up the fluid in the peritoneal cavity. The results have been excellent, and the proportion of complications, such as diaphragmatic abscess, has been lower than when the peritoneum was meticulously mopped out with gauze swabs wrung out in hot saline. Mopping up the exudate systematically appears unnecessary. If a suction apparatus is at hand, it is a convenient luxury to keep the field of operation clear.

Drainage.—A properly managed suprapubic drainage tube cannot do any harm, and it is seldom that it should be omitted except in early cases. For late cases of perforated duodenal ulcer a second tube in the right flank, designed to drain Rutherford Morison's pouch, is advisable.
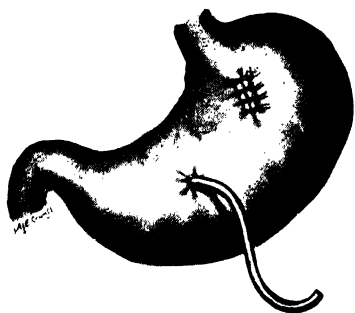
Fig. 102.—Gastrostomy following on closure of a perforation in the proximal third of the stomach.

Gastrostomy as an Adjunct.—Gastrostomy is indicated when the ulcer is in the proximal third of the stomach (*Fig.* 102). Such perforations may be difficult to close satisfactorily. Gastrostomy allows the ulcer to be kept at rest, and the patient can receive much of his nourishment through the tube.

Perforated Hour-glass Stomach.—The ulcer which gives way is saddle-shaped, and the perforation is a large one situated in a narrow isthmus. It thus comes about that the stomach may be almost in two halves. This is what was found in three cases of my series. Each was treated by simple suture reinforced by an omental graft. In each instance death occurred from hæmatemesis or internal hæmorrhage about the fourteenth day, in spite of repeated transfusions of blood in one case. I feel that the addition of a gastro-gastrostomy would probably prevent this tragic sequence, and I intend to practise the additional measure in future perforations of hour-glass stomach.

Causes of Death following Operations for Perforated Peptic Ulcer.—Stenbuck, in a detailed study of the subject, found that the principal causes of death could be categorized as follows : Within 48 hours : Shock. Within a week : Peritonitis or pneumonia. Third week : Subphrenic abscess or pylephlebitis.

Synopsis of After-treatment in all Cases of Perforated Peptic Ulcer. —After recovery from the post-operative shock, raise gradually into high Fowler's position.

1st 24 Hours.—Nil by mouth. Saline with glucose continuously or rectal ʒvj 4-hourly. Oral hygiene. Frequent mouth washes.

2nd Day. Sterile water by mouth ʒj hourly. Rectal saline with glucose 6-hourly.

3rd Day.—Sterile water ʒij 2-hourly, alternating with Benger's or Allenburys' food ʒij. Rectal saline 8-hourly.

4th Day. Sterile water ʒiij 3-hourly, alternating with Benger's food ʒiij. Glycerol enema.

5th Day.—Sterile water ʒiv 4-hourly, alternating with Benger's food ʒiv.

6th Day.—Very weak tea (strained). Custard, jelly, water *ad lib.*

7th Day.—Pounded fish. Wafer of bread and butter, no crust.

8th Day. Minced chicken.

Diet is then gradually increased. Pulv. bismuthi co. is given t.d.s. a.c. ; also liquid paraffin ʒss nocte.

Special Nursing Instructions.—Suprapubic drain to be removed forty-eight hours after operation.

All vomit must be saved, measured, and charted. Stop all feeds if patient vomits. If necessary add one or two drops of tinct. digitalis to each feed if there is a tendency to congestion of the lungs, also encourage patient to blow Woulfe's bottles.

PERFORATED GASTROJEJUNAL ULCER

Here simple suture with reinforcement by an omental graft is indicated. A jejunostomy can be added with advantage in most cases. The patient can be fed through the jejunostomy, thereby giving the ulcer a chance to heal, but in most instances further surgical treatment will be necessary when the patient's condition allows. Usually at least two or three months should elapse before such treatment is undertaken.

PERFORATED CARCINOMA OF THE STOMACH

By the time that a carcinoma of the stomach has perforated the condition is practically hopeless. Suture may be attempted, but it is often found that the sutures merely cut out, in which case an omental patch is used.

CONDITIONS SIMULATING PERFORATION

The Diagnosis is Doubtful (? Appendicitis, ? Perforated Duodenal Ulcer).—Occasionally it is well-nigh impossible to be certain whether the case is one of a perforated duodenal ulcer leaking into the right iliac fossa (via Moynihan's gutter — *Fig.* 103), or acute appendicitis. When this doubt exists it is a good practice to make a small gridiron incision. If the fluid in the peritoneum is odourless and the appendix is unperforated, the latter is obviously not the source of the trouble, and the appendix is removed, the gridiron incision closed, and the upper abdomen opened. It should be noted that the appendix often
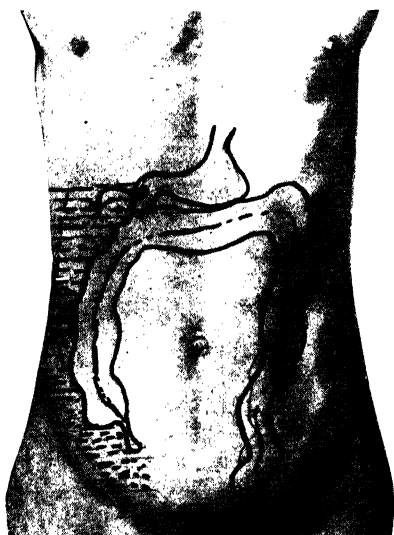
Fig. 103. — ' Moynihan's gutter', which explains how the symptoms and signs of perforated duodenal ulcer may be referred to the right iliac fossa.

Fig. 104. — The appendix is not culpable. Ascertaining if there is fluid in the upper abdomen.

looks a little inflamed when it has been bathed in duodenal contents. If there is purulent fluid in the peritoneum, and the inflamed appendix is unperforated, get someone in the theatre to slit up the appendix.

If the appendix is the source of the trouble it will surely be more pathological on the inside than on the outside ; if not, this organ is blameless. Search elsewhere. On more than one occasion I have derived help from passing up a swab on a holder towards the duodenum and leaving it *in situ* for a moment or two (*Fig.* 104). Obviously if on removal the swab is soaked with non-odorous fluid it is imperative that the upper abdomen be explored.

Pseudo-perforated Ulcer.—Occasionally cases are encountered which present many, if not all, of the characteristics of a perforated gastric ulcer, yet on laparotomy nothing is found. The gastric crisis of tabes, of course, is a well-known trap, but this is so familiar that I venture to think this error is very seldom made at the present time. In this connection it is interesting to refer to *Case* 75 of my series. This patient had both tabes dorsalis and a perforated duodenal ulcer. The diagnosis of perforation was clinched by the elicitation of shifting dullness.

An acute exacerbation of symptoms of chronic gastric ulcer may simulate a perforation of that ulcer. Usually rigidity is localized, but occasionally it is not possible to be certain if the ulcer has perforated or not. If doubt exists, laparotomy should be performed.

W. C., aged 46, gave a typical gastric ulcer history extending over 5 years. At 6 p.m. he was seized with agonizing abdominal pain, and his doctor sent him to hospital at 10.30 with the diagnosis of perforation.

He presented a classical picture of perforated gastric ulcer, as regards board-like rigidity. There was one extraordinary feature of the case—the agonizing pain came in spasms, and radiated down the arms to the finger-tips. He had two such spasms whilst being examined. Wishing to exclude the possibility of a cardiac lesion I asked my medical colleague to see him. As the heart and lungs were found to be normal, immediate laparotomy was done. A large angry pyloric ulcer was found, but no perforation. Posterior gastro-enterostomy was performed. Recovery and relief.

PERFORATION OF AN INFLAMED DUODENAL DIVERTICULUM

G. P. B. Huddy's Case.—

A married woman, aged 27, complained of epigastric pain. On the following day the pain became more acute, and she vomited four times. On examination, the temperature was 101·5, and there was rigidity and tenderness over the upper part of the right rectus muscle. A diagnosis of acute appendicitis, with the appendix under the right lobe of the liver, was made.

On opening the abdomen by a paramedian incision the appendix was found to be normal. This was removed. Flakes of lymph were seen on the peritoneum in the upper part of the wound, and a lump was palpable in front of the right kidney. The skin incision was prolonged upwards, and an incision made through the peritoneum on the outer side of the second part of the duodenum. It was then possible to isolate a pouch connected with this part of the duodenum. The pouch had a diameter of an inch, was thin-walled, and black in the centre. The diverticulum was excised, and the base closed. It was found impossible to invaginate the suture line satisfactorily. The friable peritoneum was approximated as well as possible, and a stab drain inserted.

On the third day after operation duodenal contents began to pour out of the stab drain. This gradually ceased, and the stab wound closed on the 17th day. Recovery.

PERIGASTRIC ABSCESS

Perigastric abscess is nearly always due to a perforation in the stomach or duodenum. There is little to be done except to drain the abscess in the first instance. The mortality of the condition is considerable. A complication to be watched for is gastric or duodenal fistula, the latter being the graver complication.

Duodenal Fistula complicating Perigastric Abscess.—A man of 53 had a perigastric abscess, which was opened and drained. On the 6th day food and bile came through the wound, and within twenty-four hours the abdominal wall had become excoriated in spite of dressings of horse serum. A few minutes after taking food most of the bolus appeared in the dressing. Forty-eight hours later the patient was losing ground so rapidly that operation was advised. He was fed rectally for twenty-four hours, the left upper abdomen was then opened under gas and oxygen, and gastrojejunostomy with pyloric exclusion was performed without much difficulty. Two days later the patient developed gastric tetany and died.

Berg's operation (gastro-enterostomy and pyloric exclusion) appears to be an excellent measure for duodenal fistula occurring after rupture of the duodenum (*see* p. 188); but for a patient worn out with a gastric ulcer which has perforated and given rise to a perigastric abscess it is too severe a measure.

Fig. 105. - Suction apparatus used in a case of duodenal fistula (*Cameron*).

Cameron has treated successfully a duodenal fistula by connecting the wound with an electrical sucking machine (*Fig.* 105). The electrical apparatus was run continuously for eleven days in Cameron's case, 700 c.c. of bile being recovered, and spontaneous healing resulted. Jejunostomy is also a good line of treatment, and can be performed under local anæsthesia.

R. Warren's Case.—

A man of 50 had a perigastric abscess which was opened. A few days later almost all the food he took came out through the opening. Jejunostomy was performed, and the patient fed in this manner for five weeks, by which time the abscess was healed and he was able to take food by mouth.

Conclusions.—In duodenal fistula following perigastric abscess endeavour to fix up some form of suction to keep the wound dry. The electrical sucker is the ideal instrument for the purpose, but a Cathcart's evacuator would probably act quite well. Protect the skin edges with horse-serum dressings. If the patient is not able to obtain sufficient nourishment, jejunostomy under local anæsthesia is indicated.

GASTRIC TETANY

This rare complication, seen in cases with chronic dilatation of the stomach, may occur after gastric operations. The spasms are usually confined to the extremities, and the attacks are accompanied by dyspnœa and cyanosis. If the stomach is dilated it should be emptied and kept empty with a Ryle's small stomach tube, the fluid being aspirated at intervals. Continuous intravenous saline and glucose should be administered without delay. Parathyroid extract is said to be of value, also calcium chloride, ½ gr., intravenously.

HÆMATEMESIS AND MELÆNA

It is important to recognize that there are two main conditions which give rise to severe hæmatemesis : (1) *Gastrostaxis* : The hæmorrhage occurs from a number of oozing points. If the stomach is examined at necropsy no definite lesion can be demonstrated. This condition is peculiar to women, and is usually seen in early adult life. (2) *Hæmorrhage from the erosion of a vessel in the wall of a chronic peptic ulcer* : This type is more common in men. A careful history, combined with a consideration of the age and sex of the patient, will often elucidate with which condition we are dealing.

Gastrostaxis. Under no circumstances, either immediately or remotely, is operation indicated. Rest, withholding all food and fluids by mouth, morphia, water per rectum (tap water does not make the patient so thirsty as saline), hæmoplastin subcutaneously, and perhaps adrenalin per os, are the lines on which treatment is based. These patients usually come under the care of a physician, and the great majority recover with medical treatment. On the other hand, this type of gastric hæmorrhage may prove fatal in spite of such treatment. I have seen three cases at necropsy, and have marvelled at the fact that a fatal hæmorrhage can occur from an apparently normal-looking stomach. In the more severe type the surgeon is asked for his opinion. Again, *under no circumstances advise operation.* Blood transfusion can be recommended safely. I have had the opportunity of transfusing a number of these cases. Several were at death's door. There is hardly a more satisfactory condition to treat. The benefit from transfusion is immediate, and the hæmorrhage nearly always ceases from the time of the transfusion. In very anæmic patients a second transfusion in a week's time is advisable.

Very occasionally the hæmorrhage recurs after transfusion. In the following case six transfusions were carried out.

I was called to see M. W., a married woman aged 43, one Sunday afternoon in the spring of 1928. The foot of her bed was on high blocks. Even so, she was pulseless, blanched, and had been pronounced to be dying earlier

in the afternoon. The history was that she had had pain after food for about a month. Two days previously there had been violent hæmatemesis and melæna, which had recurred in spite of medical treatment.

A boy scout was sent for, and she was transfused with a pint of his blood, with immediate and considerable benefit. Four days later she was given an enema, afterwards felt faint, and soon relapsed into the same desperate condition. She was transfused from her brother, who had been grouped and was standing by in readiness. Six days later she again felt faint, and after passing a stool of clotted blood, was almost as bad as when seen on the first occasion. She was again transfused. At short intervals of a few days the story was repeated, and five times she was rescued from a dying condition by transfusion. After the fifth transfusion I felt that there must be a chronic gastric ulcer bleeding, and on making further inquiries from a relative, it was learned that she had been under treatment for gastric trouble fifteen years previously. After yet another transfusion (the sixth), the abdomen was opened under gas and oxygen. The stomach and duodenum were perfectly normal to sight and touch. The incision was therefore closed as quickly as possible. From this time onwards she made steady progress, and was quite well when seen nine months later.

Severe Hæmatemesis from a Chronic Gastric Ulcer.—This is a difficult subject, requiring much judgement. The following points should be borne in mind :—

Fig. 106.—Chronic gastric ulcer with a large gaping artery in the crater. From a sketch made in the post-mortem room in the case of a man of 68 who died from hæmatemesis.

1. Hæmatemesis from a chronic gastric ulcer tends to recur. While very few patients die from the initial bleeding, many do so from a second or third hæmorrhage.

2. Operation attempted whilst the bleeding is in progress, or soon afterwards, is attended by a high mortality, which has not lessened substantially since blood transfusion became more general.

3. Gastro-enterostomy cannot possibly stop the spurting of an eroded artery. (A rapid gastro-enterostomy was considered good treatment some years ago.)

4. Owing to the very free anastomosis, ligature of arteries surrounding the stomach is an entirely unreliable method of controlling arterial hæmorrhage.

5. In comparatively rare instances immediate or very early operation is indicated. When it is, the bleeding point should be attacked directly.

We will assume that the surgeon has been summoned urgently to a case of severe hæmatemesis. The patient is in a poor condition, and the usual medical régime has failed. In such cases a simple blood transfusion can be recommended. The old bugbear that one must tie the vessel before transfusing the patient is largely a theoretical concept. Blood transfusion tends to stop the hæmorrhage, at any rate temporarily. After the transfusion, general treatment (morphia. rectal tap water, etc.) is instituted again, and arrangements are set in motion for further transfusion should it become necessary. For instance, in one case I had a near relative accommodated in the building for a week, ready to act as a donor. In most cases. by simple blood transfusion, it is possible to tide the patient over for
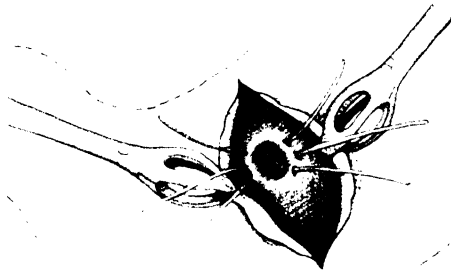
Fig. 107. Transgastric suture of a bleeding gastric ulcer.

a fortnight or three weeks until his general condition is satisfactory. when an operation, designed both to stop further hæmorrhage and to cure the ulcer, is advised.

In rare cases the hæmorrhage recurs soon after transfusion (*Fig.* 106). It is then that re-transfusion, for which arrangements have been made, is performed. If the interval between transfusion and the necessity for re-transfusion has been several days, it is advisable to wait forty-eight hours before operating. If this interval has been shorter, it may be advisable not to wait so long, or even not to wait at all.

When operating has to be undertaken under these circumstances, lives will be saved by reducing the intra-abdominal manipulations to the barest minimum. We should realize that we are not operating

for chronic gastric ulcer, but to save life from bleeding. The patient is weak and dosed with morphia, so local anæsthesia will usually suffice. Through a mid-line incision the stomach is delivered. The approximate position of the ulcer is located by touch. After packing off the area the stomach is opened. Unless the ulcer is adherent to the pancreas, it may be pushed towards the incision by the fingers on the outside. Using deeply-placed, interrupted sutures of well-tanned catgut, the whole of the ulcer is obliterated (*Fig.* 107). This operation can be carried out in most ulcers, but may have to be modified to suit special circumstances. For instance, in a very large ulcer, unless the actual bleeding point can be seen and oversewn, recourse may have to be made to the cautery, a less reliable method than suture. The bleeding point is attacked, and the cure of the ulcer left until another day.

To recapitulate : In severe hæmatemesis from a chronic gastric ulcer put your trust in blood transfusion and re-transfusion. If urgent operation is unavoidable, sew up the ulcer from within.

EMERGENCIES ARISING AFTER GASTRIC OPERATIONS

Probably no class of case is so worrying as dealing with an emergency following gastro-enterostomy. Particularly unenviable is the lot of a young surgeon who has to decide the right course of treatment when he has not performed the original operation.

Two special emergencies after gastro-enterostomy are : (1) Hæmatemesis ; (2) Vicious circle vomiting. Fortunately, both of these are now rare, and they are getting rarer. But, for this very reason, we must be adequately prepared for them.

Hæmatemesis.—Loosening the clamps after a second row of sutures has been inserted and waiting a few moments to see if there is any bleeding point, has reduced the incidence of post-operative hæmatemesis enormously. Though bleeding following gastrojejunostomy is nearly always from a vessel in the suture line, the possibility of the ulcer being the source of the hæmorrhage must be considered. In order to get a thorough grasp of the type of case with which we are at present concerned we will describe an actual example.

The patient has a gastro-enterostomy performed early in the afternoon. At 10 p.m. he vomits rather bright-looking blood. Twenty minutes later he has a large vomit consisting of clots and bright red blood. How is the case to be managed ?

If the general condition is good, adopt the following :

1. Wash out the stomach gently with 2 per cent bicarbonate of soda in normal saline at 120° F., and into the last portion of the wash add a drachm of adrenalin. If there are no clots in the vomitus try a Ryle's tube for washing out the stomach in the first instance. If

clots are present or the Ryle's tube becomes blocked, a large stomach tube must be substituted.

2. Have the pulse recorded on a separate piece of paper pinned on the chart.

3. Give morphia ¼ gr. subcutaneously.

4. Get the blood grouped and arrange for a suitable donor to hold himself in readiness.

Whilst a most conservative attitude should always be adopted towards reopening the abdomen, there should be no such attitude towards blood transfusion. Re-suture of a bleeding anastomotic suture line I have seen brought to a successful conclusion when death would have been inevitable with any but operative treatment. Nevertheless, such cases are, unfortunately, exceptional. A more usual result is to find that, whilst the patient recovers from the second operation and gives every hope of recovery, a curious post-operative peritonitis supervenes about the fifth day, and death quickly follows, the terminal stages being characterized by a low muttering delirium. A former colleague of mine noted this unhappy sequence of events in three consecutive cases. This depressing picture should not induce us to fold our hands when we ought to be opening our instrument bag, but rather serve to impress upon us to try, if possible, to arrange for transfusion before deciding to operate in all but the most urgent bleeding. An experience of ordinary cases of hæmatemesis leads one to suppose that blood transfusion, repeated if necessary, will often stop the hæmorrhage—or rather tide the patient over a critical

Fig. 108. Method of inspecting the interior of the stomach by incising the anterior wall. By this method a bleeding point on the line of the anastomosis can be seen.

period, rendering an immediate operation unnecessary. If the bleeding continues in spite of transfusion, if it is thought wiser to hurry forward the operation, or if a suitable donor cannot be obtained quickly enough, then operation must be undertaken.

Operation.—The skin is prepared as carefully as possible. The sutures are cut with scissors, and the abdomen is reopened. It is unwise to omit to place towels accurately on the skin edges, for infection is very prone to supervene when the abdomen has to be reopened before the original incision has had time to heal. The stomach is delivered. There are then two possible courses to follow :—

Method 1: Open the anterior wall of the stomach opposite the posterior gastro-enterostomy (*Fig.* 108) and inspect the interior. After

swabbing out the blood and blood-clot look first at the posterior suture line and then the anterior. If no bleeding point is discovered, the gastro-enterostomy is grasped by placing a stay suture at each end. These are drawn up and the gastro-enterostomy is pulled up into full view. Using a lockstitch the circumference of the gastro-enterostomy is oversewn. This will control the hæmorrhage. The gastro-enterostomy is allowed to fall back. This method would appear to be the better, and was used by Estes on two occasions with absolute success. The anterior stomach wound is closed by a double layer of sutures.

Method II : The fixation stitches in the mesocolon are cut. Clamps are applied and the anterior rows of the anastomosis unpicked. The gastric clamp is then loosened and the posterior row inspected. A bleeding point is dealt with. If no such bleeding point is found, the posterior layer is reinforced, and from thenceforward the steps in the operation are exactly the same as an ordinary gastro-enterostomy. In a successful case at which I assisted this method was employed.

Remembering that post-operative peritonitis is prone to follow this reopening of the abdomen, every possible precaution of packing off the area with hot moist abdominal pads should be taken.

In severe hæmatemesis following partial gastrectomy, re-operation is absolutely contra-indicated. Blood transfusion offers the only hope.

Remote Severe Post-operative Melæna. Severe melæna sometimes occurs a week to ten days or more after gastro-enterostomy. The particular type of case this uncommon complication seems to favour is duodenal ulcer with stenosis. When hæmorrhage occurs so remotely, it is unlikely that the bleeding is coming from the anastomosis – it is the ulcer which is bleeding. This type of hæmorrhage is liable to be overlooked, especially as the patient has probably been doing well up to the time of its onset. In a case of this description in which blood transfusion plus laparotomy was performed, the operative part of the treatment (opening the duodenum and cauterizing the ulcer) was not satisfactory, for adhesions made the operation very difficult. Simple blood transfusion, and arrangements for re-transfusion if necessary, is the treatment to be recommended.

Vomiting after Operations upon the Stomach : Vicious Circle Vomiting. *If the vomits are large, the patient collapsed, and particularly if the untoward symptoms come on suddenly, it must be assumed that some degree of acute dilatation of the stomach is present, and treatment is conducted accordingly (see* p. 102).

During the first forty-eight hours after operations upon the stomach, a proportion of patients bring up bile in varying quantities. In order that we may be in a position to judge whether the stoma is functioning, orders are given that the vomitus is to be measured and recorded on a separate slip (*see* Chart, p. 119). From this special

chart are added up the amounts vomited during a given twenty-four hours. If the total is in the neighbourhood of 50 oz. it is certain that the stoma is not functioning. Vomiting occurring during the first forty-eight hours after operation is not as a rule a matter for serious concern. This vomiting is no doubt due to a local ileus of the intestine in the neighbourhood of the stoma, consequent upon the operative trauma.

VOMIT CHART.

DATE	TIME	QUANTITY	NATURE
20 2 29	4.30 p.m.	℥j	Dark brown fluid
	6.15 p.m.	℥j	,, ,, ,,
	7.30 p.m.	℥ij	,, ,, ,,
	9.40 p.m.	℥iv	,, ,, ,,
21 2 29	1.30 a.m.	℥ij	Bile
	6 a.m.	℥v	,,
	7 a.m.	℥ij	,,
	8.30 a.m.	℥ij	,,

Treatment of Vomiting Occurring during the first Forty-eight Hours. —Withhold everything by mouth. Administer ¼ gr. of morphia. After straining through gauze, the vomited bile is mixed with normal saline and returned to the patient per rectum. Nothing is given by mouth until the vomiting has definitely ceased for twenty-four hours, when the usual post-operative graduated feeds are commenced.

Treatment of Vomiting that still continues after Forty-eight Hours. If the vomiting still continues in spite of the above régime, the stomach must be aspirated and irrigated through a Ryle's tube, and the irrigation continued until it is returned quite clear, when 2 or 3 oz. of the solution (2 per cent sodium bicarbonate), to which has been added 1 min. of ac. hydrocyan dil., is left in the stomach. After this the patient is ordered ¼ gr. of morphia and ½ c.c. of pituitrin, and a rectal saline with glucose is given continuously. The semi-prone position may be adopted with advantage. The tube may be left *in situ* and the stomach aspirated at intervals or continuously (*see* p. 101).

If the vomiting recommences after this, a serious view of the case must be taken. Referring to the vomit chart, we can see whether the obstruction to the outflow to the stomach is complete. Fifty ounces of bile vomited during twenty-four hours subsequent to gastric lavage, or a renewal of violent vomiting soon after the stomach has been washed clear, is very suspicious of a vicious circle. True, it is possible that the obstruction may be due to œdema of the stoma, a rather theoretical concept. If the condition of the patient is not

deteriorating, it may be advisable to rely upon gastric aspiration and irrigation, a course which is to be definitely pursued and persisted in if the calculations show that even one-third of the bile is passing through.

While we are most reluctant to reopen the abdomen, a time is reached when, in our judgement, it is unwise to delay longer. The stomach is washed out, the patient given morphia, and saline and glucose per rectum. If he has been starved for some days, a nutrient enema may be given. Operation is arranged to take place in about three or four hours' time. Under gas and oxygen the abdomen is reopened, and every precaution possible is taken to avoid infecting the peritoneum from the skin. The first thing to ascertain is whether there exists an obvious obstruction distal to the anastomosis. By tracing the loop downwards for about a foot, especially if it is not dilated, this is at once ruled out.

If the previous operation has been a gastroduodenostomy, the indication is clear—perform gastro-enterostomy.

If the operation was an anterior gastro-enterostomy, anastomose together the efferent and afferent loops. These loops are accessible and the operation is simple.

If the operation has been partial gastrectomy, anastomose together the efferent and the afferent loops. Again these loops are accessible, and the technical part of the operation presents no particular difficulty.

If the operation was a posterior gastro-enterostomy, turn up the colon and observe the transverse mesocolon and the stoma. Perhaps the hole in the transverse mesocolon is small, and the anchoring sutures have failed to prevent the anastomosis slipping upwards into the lesser sac, thereby kinking the jejunum. *Such findings are quite exceptional.* If there is a definite kinking of the efferent loop from this cause, the stoma is drawn downwards and the stomach wall in the region of the anastomosis is firmly sutured to the mesocolon, care being taken to avoid including the middle colic artery in one of the stitches.

In one such case I was able to demonstrate clearly a kink caused by a retraction of the stoma upwards into the lesser sac, a rectification of which immediately put matters right. Encouraged by this success, on the next occasion on which it was necessary to reopen the abdomen I thought such a kink existed, and re-arranged the mesocolon about the gastric side of the stoma, but without benefit.

Unless something really definite and remediable is found, we must proceed to design a method by which the bile is short-circuited from the afferent to the efferent loop (*Fig.* 109).

Anastomosis between the efferent and afferent loops after the modern no-loop posterior gastro-enterostomy may be difficult. It is,

however, the most practical solution to the problem when loops can be brought into juxtaposition. I have carried out the measure with success and have also regretted not having resorted to it earlier.

In very ill patients with vicious cycle vomiting Hugh Donovan recommends, and has practised successfully, the following excellent procedure. Under local anaesthesia the abdomen is re-opened. A large self-retaining catheter (Malecot type), stretched on an introducer, is inserted into a small opening in the stomach and guided through the stoma down the efferent loop of jejunum for six to eight inches. The operation is then completed as a Senn's gastrostomy. A feed can be given down the tube on the operating table. In successful cases the Malecot catheter is removed about the eighth day, and usually the gastrostomy opening closes spontaneously.

Fig. 100. Anastomosing the efferent and afferent loops. The second layer of sutures is about to be inserted.

Retrograde Intussusception after Gastro-jejunostomy. In the majority of cases the intussusception occurs long after gastrojejunostomy has been performed. In two recorded cases the patient was pregnant at the time. If the condition is borne in mind, it is by no means impossible to make a correct pre-operative diagnosis. Symptoms occur suddenly. The pain is griping, epigastric, colicky. Vomiting soon occurs, and is frequently repeated. The vomitus is first of all food, then bile, and then blood. Rigidity and tenderness are absent, and perforated gastrojejunal ulcer can then be ruled out. In six recorded cases a lump had been felt in the epigastrium.

Hamilton Drummond's Case.—

A platelayer, aged 35, on the previous day was seized with spasmodic epigastric pain after taking food. The pain, coming in spasms, had continued, and he had vomited many times, latterly almost pure blood. The patient looked ill. The pulse was 96 and the temperature 98°. Whilst under observation he had several attacks of pain accompanied by small vomits of blood. Examination revealed a scar in the epigastrium. He had had gastro-enterostomy performed sixteen years previously. There was no tenderness or rigidity. Two hours after admission laparotomy was performed. The proximal loop of the anastomosis was enormously dilated.

About six feet of small intestine from the distal loop had become intussuscepted into the stomach (*Fig.* 110). This was easily reduced.

After the abdomen has been opened and the condition recognized, reduction is undertaken by squeezing the mass in the stomach towards the stoma. In all cases reduction has been easily accomplished. If the condition is not remedied by operation, it is usually fatal.

Fig. 110.—Retrograde intussusception of the small intestine after gastro-jejunostomy.

ACUTE PHLEGMONOUS GASTRITIS

As this condition is neither excessively rare nor necessarily fatal, it will receive some detailed consideration.

Acute phlegmonous gastritis was called by Rixford "acute suppurative cellulitis of the stomach", and the latter nomenclature conveys an accurate picture of its pathology. The stomach is swollen and angry, and pus is found in the submucosal layer (*Fig.* 111).

Lord Moynihan's Case.—

The patient, a boy aged 17, was taken ill a few hours after eating pork pie. He complained of acute abdominal pain, and there was exquisite epigastric tenderness.

The epigastrium was distended, and the abdomen, inflated in its upper part but retracted below, presented a very striking and unusual appearance.

The boy was very ill; the pulse was never less than 118; there were collapse, vomiting, and profound prostration, which ended in death about thirty-eight hours after the onset of symptoms. At the post mortem a typical and most acute phlegmonous gastritis was found. No lesion of the mucous membrane of the stomach could be seen.

The offending organism is nearly always a streptococcus. The solitary exception appears to be a case in which the pneumococcus was found. When the stomach has been examined after death, the mucosa has been found to be intact and comparatively normal in all but a few instances. In these exceptions a carcinoma or a chronic gastric ulcer has been present.

Fig. 111.   Lord Moynihan's case of phlegmonous gastritis.

In its most acute form the cellulitis invades both walls of the stomach from the cardia to the pylorus. There is a localized form of the disease which, when situated near the pylorus, has been successfully treated by partial gastrectomy, as in Gerster's cases.

The diagnosis is exceedingly difficult, if not impossible. In the very acute generalized forms, acute pancreatitis, perforated gastric

ulcer, and pneumonia enter the clinical picture ; while in the variety confined to the pylorus, acute cholecystitis appears to be the most likely pre-operative diagnosis.

Treatment of the Generalized Variety.— Local anæsthesia, supplemented if necessary by gas and oxygen, is advisable. On opening the abdomen some perigastric peritonitis is likely to be found. The stomach is infiltrated and inflamed, its walls being likened to wet blotting paper. If any doubt exists as to the nature of the condition, we may avail ourselves of Rixford's suggestion and insert a hypodermic syringe into the stomach wall. This author withdrew thick muddy pus into the syringe from the submucosa.
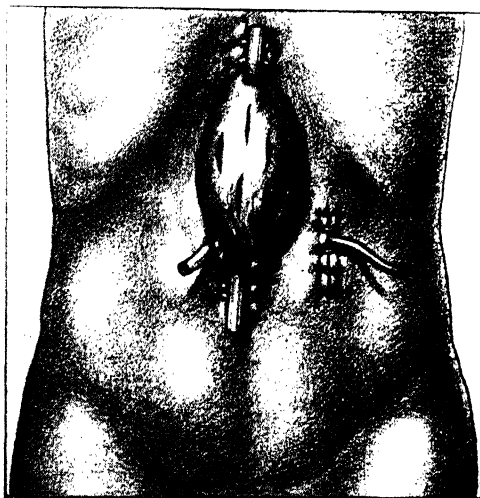
Fig. 112.—Acute phlegmonous gastritis. Generalized form. Incisions are made down to the submucosa. The stomach is brought on to the surface and maintained there by a glass rod. The tube on the patient's left is a jejunostomy, for purposes of feeding. The tube entering the lower part of the incision passes into the lesser sac.

As death occurs from peritonitis spreading from the stomach, it has been suggested by Weinstein and Klein that the stomach should be delivered on to the abdomen as is done in Paul's operation for carcinoma of the colon. Having opened the lesser sac between the stomach and the colon, a glass rod, or failing that a long hæmostat or even a length of gauze, is passed behind the stomach and made to emerge above the lesser curve through the gastrohepatic omentum. The incision is then closed about the prolapsed stomach. A piece of omentum may be included about the lowermost stitch which draws together the abdominal wall below the stomach. This omentum will

act as a barrier between the stomach and the general peritoneal cavity. Multiple incisions are made down to the mucosa. Incisions on the posterior surface are made prior to the introduction of the rod behind the stomach. Drainage of the lesser sac by a tube passing alongside the rod is necessary (*Fig.* 112). The prolapsed stomach is covered with hot moist gauze. The operation is concluded by performing jejunostomy through a separate incision to the left and a little below the original incision. Through the jejunostomy the patient is fed.

We may take advantage of the knowledge that the condition is caused by a streptococcus, and administer anti-streptococcal serum in addition to the general post-operative treatment.

Hypertrophic Pyloric Stenosis of Infants is seldom an emergency condition. Occasions arise when it becomes really urgent to relieve the pyloric obstruction. The stomach should be washed out and a saline and glucose infusion given. The operation is best conducted under local anæsthesia. The abdomen is opened by an incision over the pylorus, the rectus muscle being either retracted outwards or split vertically. The greatly hypertrophied pylorus is held in the finger and thumb and rotated somewhat so that the upper surface comes to look forwards. The muscle coats are incised down to the mucosa (*Fig.* 113), great care being exercised not to perforate the mucous membrane, an accident especially liable to occur where the hypertrophied pylorus terminates abruptly to join the comparatively thin duodenum. Using a blunt dissector, the thickened muscle which cuts like an unripe pear is eased from the mucosa at the bottom of the wound and the mucosa bulges into the incision. It is a good practice to place a tiny piece of muscle from the rectus in the pyloric incision—this helps to arrest oozing. The abdomen is closed. The feeding of the patient after the operation requires strict supervision. Very small feeds are the order of the day, especially during the first three days.
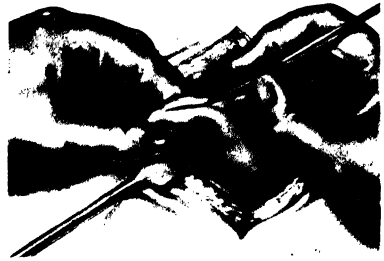
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CHAPTER X

THE GALL-BLADDER AND BILE-DUCTS

GALL-STONE COLIC

GALL-STONE colic should be treated by an injection of morphia and hot fomentations to the upper abdomen.

If the attack is followed by jaundice it is almost certain that a stone has entered the common duct. Even when the jaundice is unmistakable good results often follow expectant treatment. It is my practice never to be in a hurry to operate upon a patient who has had recently an attack of gall-stone colic. Even in cases of moderately deep jaundice, by waiting patiently for a week or more we can often spare her having an operation at an unfavourable time, for so often the jaundice clears even though at the subsequent operation a stone or stones are found in the common duct. Jaundice means depressed liver function. Operation on patients with a depressed liver function will result in a percentage of unexpected deaths in the post-operative period, fatalities which are often unexplained by morbid anatomy.

As soon as the acute symptoms have subsided, felamine—a biliary antiseptic, two tablets taken with a full glass of cold water twice daily—can be prescribed, and is of some value.

While the above remarks concerning cases of early obstructive jaundice will be found applicable in most instances, occasionally there will arise examples when the jaundice is becoming deeper and the patient's temperature suggests that cholangitis is likely to supervene. Here, of course, to delay unduly would be a surgical misdemeanour. The operative treatment of obstructive jaundice is discussed on p. 139.

CHOLECYSTOSTOMY

The indications for urgent cholecystostomy are :—

1. Fulminating cholecystitis. Failure of expectant treatment.
2. Empyema of the gall-bladder.
3. Diagnosis uncertain. Acute inflammation of the gall-bladder found.
4. Perforation of the gall-bladder.
5. As a subsidiary therapeutic measure in acute pancreatitis.
6. Stone impacted in the common bile-duct, and cholangitis and cholæmia threatening life.

Operations on the gall-bladder are made easier by having a sand pillow under the back about the level of the 11th dorsal vertebra. Most modern operating tables are provided with a movable bridge
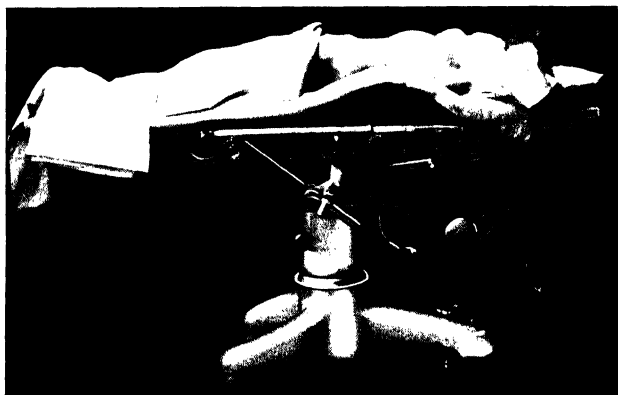
Fig. 114. The gall-bladder position showing the bridge table elevated.

(*Fig.* 114), which is more convenient than the pillow. It is important to see that the patient is in the correct position for this bridge to function *before* the operation is commenced. The adoption of this position is essential for cholecystectomy, but is hardly necessary for most operations of cholecystostomy. It is, however, a useful stand-by.

Cholecystostomy can be performed through the mid-line incision, sometimes readily. If the patient is fat, the gall-bladder small, and

Fig. 115. Incision for draining the gall-bladder. In this case in addition to cholecystostomy the right kidney pouch was drained through a stab incision in the flank.

the anæsthetic troublesome, the operation may be distinctly difficult by this route. The right paramedian incision with retraction of the rectus outwards gives very fair exposure. An incision over the right

rectus, splitting that muscle, provides even better exposure than the
paramedian incision. By this route the abdomen is more easily and
more quickly opened, and certainly more readily closed, than by the
paramedian, especially if the anæsthetic is not all it should be.

The limited transverse incision (*Fig.* 115) is the one I favour for
cholecystostomy when the diagnosis is certain. It gives good access
to the gall-bladder and it does not disturb nature's barriers around
the seat of infection. I have used this incision under local anæsthesia
with perfect satisfaction.

B
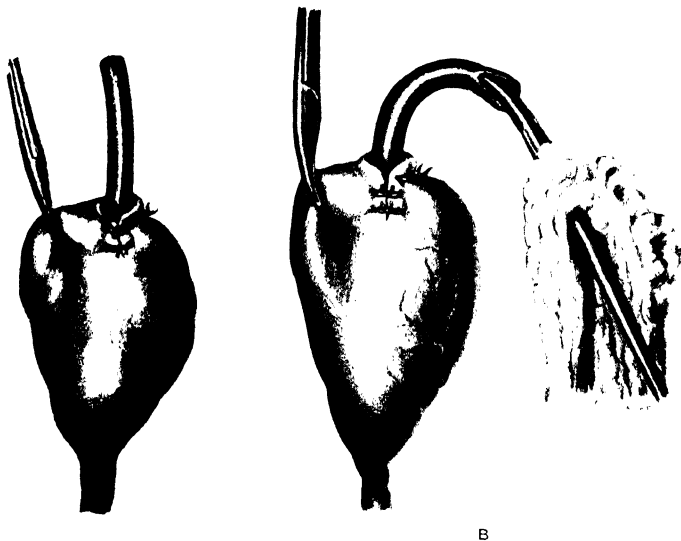
A. When the
tous the incision is closed about the tube by interrupted stitches. B. The tube
is then brought through a convenient portion of omentum, which reinforces
the suture line.

The Transverse Incision. Directly over the fundus, if the gall-
bladder is distended, or over the anatomical surface marking, an
incision is made designed to bisect at right angles the right rectus
muscle. Towels are clipped to the skin edges. The rectus sheath
is divided in the length of the incision and the fibres of the rectus
are displayed. With light touches of the scalpel the muscle fibres are
sectioned a few at a time, keeping strictly in the transverse plane.
Sometimes there is hardly a vessel to ligate, usually the deep epigastric
vessels require attention and a ligature on a needle is the best method
of securing a bleeding vessel in muscle.

Having located the diseased gall-bladder, and freed any adhesions
thereto, a moist gauze pad is tucked below the gall-bladder. If the

operating table is provided with a movable bridge, instructions are given at this stage for it to be raised.

A small hole is cut in the centre of an abdominal pad, and through this hole the fundus of the gall-bladder is made to appear. The pad fits snugly around the organ, and when the viscus is opened, infected bile is prevented from running down and soiling the peritoneum.

Puncture of the gall-bladder is the next step (*Fig.* 117). As often as not, when it is tense and inflamed, it is impossible to clip a point on the fundus in order to steady the organ. The fingers of the left hand are inserted under the protecting pad, and the body of the gall-bladder is steadied and pushed upwards whilst the trocar and cannula, with a sharp thrust, penetrate the fundus. As soon as the gall-bladder is emptied of some of its contents, its wall can be secured at some point to one side of the puncture in order to prevent it slipping back. When the fluid contents have ceased to flow, the cannula is removed and the fundus is opened by an incision. The edges of the incision having been grasped by haemostats, stones are removed from the interior (*Fig.* 118). Unless the calculi are very small, fenestrated forceps (*Fig.* 119) are better

Fig. 117.— Cholecystostomy. Moynihan's method of isolating the fundus of the gall-bladder. A distended gall-bladder is first punctured with a trocar and cannula, and its fluid contents withdrawn.

adapted to this work than a scoop. The fingers of the left hand beneath the the pad may aid in the removal of the calculi by milking them from the region of Hartmann's pouch towards the open jaws of the forceps. After the gall-bladder has been emptied of stones, and if time permits, it is a good practice to pass strips of gauze into the interior of the organ until it is dry. Minute calculi are often dislodged by this means. A quarter-inch drainage tube with a lateral

opening is then passed down into the body of the gall-bladder, and is retained in position by a single catgut stitch passing through the cut edge of the viscus. The gall-bladder is closed about the tube (*Fig.* 116). In large inflamed gall-bladders with thick friable walls a purse-string simply cuts out. In such cases the junction between the tube and the wall of the gall-bladder must be made as perfect as possible by the introduction of interrupted sutures, two of which usually suffice. The tube is then brought through a convenient piece of omentum (*Fig.* 116, B), which thus comes to rest upon and reinforces the suture line. If a mid-line or paramedian incision has been used, a stab wound is made over the gall-bladder and the tube is brought out through this. If the rectus has been split, the tube may be brought directly through the laparotomy incision at a convenient spot, in which case the peritoneum must be carefully and independently approximated above and below the tube. After the abdomen has been closed, the tube is brought directly through the dressings, and when the

Fig. 118. — Cholecystostomy. Extracting a stone with fenestrated forceps. A scoop is also a useful instrument for this purpose.

patient has been returned to bed it is connected to a bottle for collecting the bile.

Fig. 119.—Desjardins' fenestrated gall-stone forceps.

CHOLECYSTECTOMY

A description of cholecystectomy will not be given here. We will only state that if this operation is contemplated when the gall-bladder is in an acutely inflamed state, it is doubly necessary to dissect and demonstrate clearly the cystic, the common hepatic, and common bile-ducts before dividing the cystic duct (*Fig.* 120). If, as is sometimes the case, œdema prevents this demonstration, it is safer to abandon the more radical treatment in favour of cholecystostomy.

Cholecystectomy is seldom called for in urgent surgery. To those who are practised in its technique a description is superfluous; to others, the simpler operation of cholecystostomy is recommended.

ACUTE CHOLECYSTITIS

Acute cholecystitis is not an indication for immediate operation. Intelligent inactivity during the attack, and cholecystectomy after the attack has subsided, is safer and better in every way. No one who has observed the regularity with which these cases respond to expectant treatment would wish to interfere with Nature's reparative process during the acute stage. Cholecystectomy performed after the attack has subsided carries a low mortality, and rids the patient of an organ which is most certainly irreparably damaged and likely to give rise to further trouble.

Delayed Treatment. The patient is placed in Fowler's position. Water only is given by mouth for two to three days. After this time a fluid diet is substituted until all the symptoms have subsided. For so long as the condition of the patient gives rise to anxiety the temperature and pulse are recorded every two hours. Hot fomentations or a hot bottle placed on the upper abdomen help to relieve the pain. No morphia is given for the first twenty-four hours unless the diagnosis is absolutely undeniable.

Fig. 120. Cholecystectomy. The junction of the cystic, common hepatic, and common bile-ducts has been displayed; the cystic artery has been clamped and divided.

The inactive treatment of acute cholecystitis stipulates accurate and confident diagnosis. If we are sure that the case is one of acute cholecystitis, it is seldom necessary to open the abdomen for a fortnight or more. If we cannot exclude perforated duodenal ulcer or high retrocæcal acute appendicitis of under forty-eight hours' duration, it is essential to explore. From time to time exploration is the only course, and if an acute cholecystitis is found, the gall-bladder must be drained or removed. Following this régime the number of cases

submitted to immediate operation will be inversely proportional to our diagnostic ability.

Very occasionally, whilst undergoing expectant treatment, the patient will have a recrudescence of symptoms. A return of the pain, vomiting, and a rise in pulse-rate indicate failure of the treatment. One should endeavour to exclude acute pancreatitis in this type of case. In any case, immediate operation is indicated. I have seen only 3 cases of this kind. The symptoms became urgent on the seventh, seventh, and eighth days respectively. All recovered after immediate operation.

Perforation of the gall-bladder from ulcerative cholecystitis is not very rare, but I have not seen or heard of a case where the gall-bladder perforated *whilst the patient was under treatment.* There is no denying that it is possible for perforation to occur under these conditions, but with the patient under the direct observation of the surgeon, who is able to operate immediately, even this exceedingly rare complication need not necessarily be fatal.

To recapitulate : The danger of perforation whilst the patient is under a strict régime is an infinitely small one. Should it occur, it is by no means necessarily fatal if recognized promptly, which it should be with the patient under the conditions laid down here. To recommend immediate operation in acute cholecystitis on the ground of possible perforation is unjustifiable. No one would dream of recommending immediate operation during one of the acute exacerbations of a chronic duodenal ulcer on the ground that the ulcer might perforate. Uncertainty of diagnosis remains the chief indication for acute gall-bladder surgery.

ACUTE FULMINATING CHOLECYSTITIS

Very few cases of acute cholecystitis fail to respond quickly to the non-operative régime just described. Here is an exception : —

After his evening repast a solicitor was seized with acute pain in the right hypochondrium. I saw him at 12 midnight. There was no particular difficulty about the diagnosis, for the rigidity was localized and his temperature was over 103° F. The hourly pulse-rate during the night showed a steady increase. In the early hours of the morning he had a rigor, and, contrary to most cases of acute cholecystitis, the facies was that of a very sick man. At 10 a.m. after he had had a copious infusion of saline and glucose I opened the abdomen, using the limited transverse incision. The gall-bladder was very tense and of a dusky mottled appearance. Momentarily I wondered if cholecystectomy would be the right course, for so virulent a focus might well lead to spreading peritonitis. The œdema about the cystic duct and the report from the anæsthetist that the patient's condition was poor at once negatived this course. On

puncturing the gall-bladder thin blood-stained pus came out. There was a solitary calculus wedged in the entrance of the cystic duct, which was removed by the method shown in *Fig.* 121. Cholecystostomy. The pulse-rate remained unduly fast for several days, but steady improvement in the general condition was maintained. He failed to return for cholecystectomy in six months as advised and arranged. I hear he has had mild attacks of gall-stone colic.

EMPYEMA OF THE GALL-BLADDER

As a rule the clinical diagnosis of empyema of the gall-bladder is not difficult. The temperature fails to settle in a short time, the pain continues, and there is a palpable swelling. Under such circumstances the gall-bladder must be drained. Almost without exception, a stone will be felt impacted in the commencement of the cystic duct; occasionally this is the only stone present. By judicious upward pressure with the finger and thumb (*Fig.* 121) the stone can often be expressed into the more commodious region of the neck of the gall-bladder, where it can be retrieved and removed. Disimpaction of this, the keystone of the trouble, is desirable, though not vital. If the stone remains the patient usually recovers, but a persistent muco-purulent fistula is practically inevitable.

Fig. 121.—Squeezing a stone impacted in the cystic duct into the neck of the gall-bladder.

EXTRAVASATION OF BILE

On opening the peritoneum, if pure bile is found, the following conditions must be thought of, and if the patient is not *in extremis* the source of the extravasation must be found :—

1. Perforation of the gall-bladder.
2. Perforation of the bile-ducts.
3. Perforated duodenal ulcer (second part of the duodenum).
4. Transudation of bile through the gall-bladder.

If the condition has followed an abdominal accident the three following conditions should be borne in mind : —

1. Rupture of the gall-bladder (*see* p. 181).
2. Rupture of the common bile-duct or hepatic duct (*see* p. 182).
3. Rupture of the duodenum (*see* p. 187).

PERFORATION OF THE GALL-BLADDER

Perforation of the gall-bladder into the general peritoneal cavity is a most urgent condition. The bile is heavily charged with bacteria and without operation general peritonitis soon follows.

The Time Factor.

Of	7	cases operated on within	12 hours	6 recovered.
Of	15	„	„	„	24 „	10 „
Of	16	„	„	„	3 days	8 „
Of	10	„	„	„	4 „	2 „

(McWilliams.)

Difficulties in Diagnosis. Unless we know that the patient has suffered recently with gall-stones or cholecystitis the diagnosis is almost impossible. In the absence of such data the nearest approach to a correct pre-operative diagnosis will be that perforation of a duodenal ulcer has occurred. On the other hand, with a lead the problem is not by any means insuperable.

A. H., aged 42, was admitted with a large tender swelling coming from beneath the right costal margin. The symptoms had been present for five days, but after the first few hours the pain had not been severe. Excretion pyelography showed a normal pelvis of the right kidney which heightened the suggestion that the swelling was a greatly distended gall-bladder. Two days later while his abdomen was being prepared for laparotomy he experienced a severe attack of pain which soon passed off. The pulse-rate, which had been normal, began to rise. On examining his perfectly flaccid abdomen I was astounded to find that the large lump had disappeared completely. On opening the abdomen free bile was found in the peritoneal cavity. There was a large perforation in the gall-bladder just above Hartmann's pouch, and beneath this two gall-stones lay free. Cholecystectomy with local and suprapubic drainage was carried out. Convalescence was uneventful.

Operation. When the organ is examined the perforation is not difficult to find. Its situation varies ; it may be at the fundus, or at Hartmann's pouch, or between the two. If the opening is at the fundus, it should be enlarged, the stones removed, and cholecystostomy performed. If the perforation is farther down, the gall-bladder may be slit up towards the fundus. After clearing the interior of stones and débris the gall-bladder may be reconstructed around a drainage tube. Alternatively, if the patient's general condition permits and the operator is experienced in the technique, cholecystectomy is permissible.

Drainage of the peritoneum should always be carried out by : (1) Local drainage by a stab wound in the mid-axillary line, about 1½ in. below the costal margin, in order to drain Rutherford Morison's pouch ; and (2) Suprapubic drainage in all but very early cases.

Localized Abscess Formation after Perforation of the Gall-bladder. —Unless the collection of purulent bile is considerable the diagnosis is indistinguishable from that of empyema of the gall-bladder.

F. C., aged 66, had been ill for five days. There was a large tender mass beneath the right costal margin, but the overlying rigidity made it impossible to define accurately its limits. The temperature was 103° F. although he did not appear to be gravely ill. For forty-eight hours he was nursed in high Fowler's position. As the temperature remained at this high level and he was rather worse than better operation was decided upon, the diagnosis being empyema of the gall-bladder. The abdomen was opened by the limited transverse incision described already. As soon as the peritoneum was incised bile and purulent gelatinous material escaped. A perforation was found in the gall-bladder near the fundus. A solitary calculus impacted near the fundus of the organ was expressed (*see Fig.* 121). Utilizing the perforation, which admitted the little finger, cholecystostomy was performed and the abscess cavity was drained. Free drainage of bile through the cholecystostomy tube continued for seventeen days, the tube was then removed. Convalescence was delayed by retention of urine, but a good recovery followed.

It is important to refrain from tearing Nature's barriers, which are usually the great omentum and the transverse colon. If the perforation is inaccessible or other circumstances make it difficult to deal directly with the gall-bladder, reliance can be placed in simple drainage of the abscess cavity. Seven out of eight cases so treated recovered (L. R. Fifield).

PATHOLOGICAL PERFORATION OF THE BILE-DUCTS

A man of 45, whilst walking home from work, was seized with abdominal pain. With difficulty he managed to reach his destination, a quarter of a mile distant, unaided. Twenty-two hours later he was brought to hospital. The temperature was 97°, the pulse 72, and he appeared very shocked and ill. The physical signs were typical of a perforated duodenal ulcer, and as he was a very thin man, shifting dullness could be demonstrated easily.

The abdomen was opened by a supra-umbilical mid-line incision. Pints of bile were found in the peritoneal cavity. Bile was also present in the lesser sac and *behind* the peritoneum, which was floated up. The gall-bladder looked normal, but on palpation many tiny calculi were felt within. The stomach and duodenum were examined, with a negative result. The cystic duct and supraduodenal portion of the common duct were examined with a seeker, but no perforation was demonstrable ; indeed, these structures appeared quite normal. It was concluded that there was a perforation of some part of the hepatic or common bile-duct. Cholecystostomy and drainage of the peritoneum was performed. Throughout the operation the patient received saline infusion, and he was returned to bed in good condition. Next morning his pulse was good and he stated that he felt

better. It was remarked that it was curious that he showed no signs of jaundice. Twelve hours later he collapsed and died. A necropsy showed a perforation at the back of the junction of the cystic and common ducts.

If the perforation can be found, a small rubber drainage tube should be stitched into the hole. In any case cholecystostomy and peritoneal drainage should be performed.

TRANSUDATION OF BILE THROUGH THE GALL-BLADDER

Biliary peritonitis without perforation was first described by Clairmont and Haberer in 1910. Professor Leriche records a case in which three pints of bile were found in the general peritoneal cavity. Bile was found to be dripping from a distended gall-bladder. When the surface of the gall-bladder was mopped dry, bile soon reappeared there. Cholecystectomy and drainage of the peritoneal cavity was performed. Marinacci encountered a similar case, and treated it by packing. Both cases recovered.

The pathology of the condition is obscure. The gall-bladder in these cases is found to be very œdematous, and Marinacci believes that there is a minute perforation or perforations in its wall. This theory is plausible, and should be assumed to be correct until further evidence concerning this rare condition is forthcoming.

TORSION OF THE GALL-BLADDER

Torsion of the gall-bladder is a rare condition, although several cases have been reported in this country of recent years.

Irwin's Case.

The patient was a woman 34 years of age, who had been ill for twenty-six hours. The differential diagnosis lay between acute cholecystitis and a high acute appendicitis. At operation a tense black gall-bladder was found the size of an egg. The gall-bladder had undergone one complete rotation : the twist was in the gall-bladder itself, not in the cystic duct. Cholecystectomy was performed. The gall-bladder contained blood and bile.

Huddy, in reporting a successful case in a woman of 71, remarks that with but two exceptions (Irwin's case being one of these) the patients have been old women. In his case the abdomen was opened because there was a lump believed to be an appendix abscess which did not resolve with expectant treatment. On opening the abdomen there was a well-shut-off lymph-covered cavity containing a rounded swelling which proved to be a gall-bladder that had made one turn on its neck in an anti-clockwise direction. The organ was removed with great ease, as there was a narrow mesentery in the region of the neck and it was hanging from the liver edge. As there was no raw area on the liver the abdomen was closed without drainage. On examination the gall-bladder was congested, but there were no stones. The wound healed soundly.

THE CONTROL OF ACCIDENTAL HÆMORRHAGE FROM THE CYSTIC ARTERY

The principle involved is to control the cystic artery by compression of the hepatic artery (*Fig.* 122). This can be done by placing a finger through the foramen of Winslow and the thumb overlying the free edge of the gastrohepatic omentum. When the foramen of Winslow is non-existent, the free edge of the gastrohepatic omentum is grasped *en masse*, or the vessels are compressed against the

Fig. 122. —Compressing the free edge of the gastrohepatic omentum control hæmorrhage from the cystic artery. (*Hogarth Pringle's*

vertebral column. If the hand occupies too much room the incision can be enlarged whilst the hepatic artery is being compressed. After the field has been mopped dry, by momentarily relaxing pressure on the hepatic artery the bleeding cystic artery can be located accurately, caught in forceps, and ligatured.

Post-operative Hæmorrhage.—After performing cholecystectomy almost all operators drain the area. If severe hæmorrhage occurs there are none of the difficulties of diagnosing internal hæmorrhage, for the internal hæmorrhage, by way of the tube, becomes external. In the post-operative cases in which the hæmorrhage is severe and leaves no doubt that the vessel is spurting, it is necessary to reopen the abdomen. It is important to have the patient in the gall-bladder position (*see* p. 128). The cystic artery may be proved culpable or innocent by compressing the hepatic artery, and if the hæmorrhage continues in spite of this procedure, the bleeding point must be sought for elsewhere.

OBSTRUCTIVE JAUNDICE

Most of the conditions dealt with in this work are urgent in the sense that there are but hours—sometimes, indeed, only minutes—in which to act. Obstructive jaundice can hardly be placed in this category, yet it cannot be omitted.

When the jaundice is not deep the question of early operation does not arise; the patient is observed from day to day. If the jaundice is clearing and the cause is probably, or definitely, gall-stones, operation should be postponed for a week. If the jaundice is getting deeper; if, when the patient is first seen, it is already of an olive hue; and particularly if the jaundice has been progressive and its onset painless, operation should be arranged for in twenty-four to forty-eight hours' time. During the interval active preparations (*see* p. 140) are made.

Causes of Obstructive Jaundice.

1. Gall-stone in the common bile duct.
2. Carcinoma of the head of the pancreas.
3. Subacute or chronic pancreatitis obstructing the ampulla of Vater.
4. Simple stricture of the bile ducts.
5. Malignant stricture of the common duct.
6. Metastatic carcinomatous deposits obstructing some part of the biliary system.

I do not propose to enter into this differential diagnosis, the salient features of which are well known. In spite of better understanding of the principles which govern this differential diagnosis, there are many surprises in this branch of surgery—happily, sometimes pleasant surprises. Take, for instance, the patient illustrated in *Fig.* 123. The enlarged, somewhat irregular liver, combined with deep progressive jaundice, caused a competent observer to diagnose malignant disease, in spite of the fact that the trouble started with an acute attack of pain. Unwisely, the patient was ordered a cholecystograph. As might be expected, the cholecystogram showed nothing, but the additional strain on the liver in endeavouring to excrete the dye caused him to pass into a semi-comatose condition. After a blood transfusion, laparotomy was performed. There was swelling of the whole pancreas, which was considered undoubtedly inflammatory. The much enlarged gall-bladder was drained. Continuous intravenous saline and drainage of the bile-ducts via the gall-bladder produced a remarkable improvement. Within forty-eight hours the dark jaundice had almost gone, and he has remained well.

It is my conviction that few, if any, cases of obstructive jaundice with a hold on life should be abandoned as hopeless without exploration.

Preparation for Operation.—Copious infusions of rectal saline and glucose are given. The tendency of a deeply jaundiced patient to bleed is mitigated by a blood transfusion, and the best time for the transfusion is the evening before the operation. Calcium salts can be prescribed. Definite improvement in the general condition is usually noted after the blood transfusion.
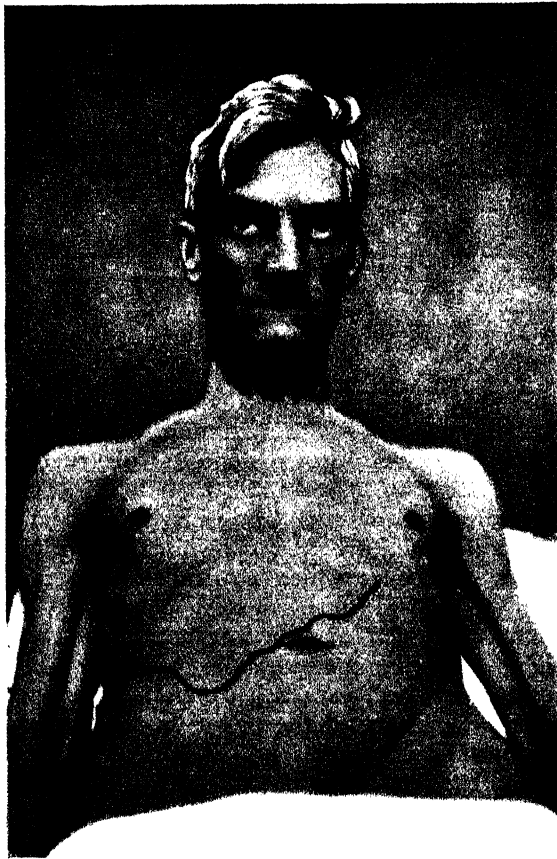
Fig. 123.—Patient with greatly enlarged, somewhat irregular liver, profound jaundice, and cachexia. One of the many surprises in this branch of surgery. Recovered completely after cholecystostomy.

Anæsthesia.—Patients with impeded liver function tolerate general anæsthesia badly. On this account local anæsthesia is advisable. On many occasions I have performed cholecystostomy and choledochostomy under local infiltration anæsthesia with a preliminary

dose of morphia. As soon as the peritoneum has been opened a quantity of $\frac{1}{2}$ per cent novocain is poured into the peritoneal cavity, which is followed by a gauze pack soaked in this local anæsthetic. Two or three minutes are allowed to elapse in order to allow the anæsthetic to take effect. In nearly all these cases no other anæsthesia has been needed. When necessary, a little gas and oxygen has been given.

The incision is a matter of considerable importance. The *mid-line* incision (p. 36) has certain advantages. It is particularly satisfactory for use with local infiltration; it is an avascular route, and it gives excellent access to the common bile-duct. The mid-line incision is as good as any, and better than most, for a set operation of choledochostomy. The *paramedian* is a very good incision. It is a little more difficult to infiltrate satisfactorily, and when this incision is employed more time is expended in opening and closing. This is the best incision to employ when the cause of the obstructive jaundice is doubtful, for it gives fair access to both the gall-bladder and the common bile-duct. The *limited transverse* incision (p. 129) is excellent for simple cholecystostomy.

The Operation.—As to the proper procedure to adopt in a given case, much judgment is required. Throughout the operation the surgeon must have his objective like a beacon light shining brightly before him. Primarily, it is to relieve the obstruction; secondarily, and far less important, it is, if possible, to remove the cause of the obstruction.

As soon as the abdomen has been opened, examine the gall-bladder.

The gall-bladder is large and tense; the patient is old, and jaundice is profound. Without further ado open the gall-bladder as shown in *Figs.* 117 and 118. If green bile flows out in considerable quantities one knows that the obstruction has been relieved. Under such circumstances rest content in performing cholecystostomy. When the flow from the gall-bladder is light-coloured, mucoid material, after satisfying yourself that there is no obstruction to the cystic duct, assume that this is white bile. ' White bile ' is an accompaniment of the last stages of biliary obstruction. Drainage of the biliary passages via the gall-bladder will give the patient a fighting chance.

The gall-bladder is large and tense; the condition of the patient is fair. Palpate the pancreas. If there is a hard, irregular mass in the head, the case is probably one of carcinoma of the head of the pancreas, but not irrefutably so. If the *whole* pancreas is enlarged it is undoubtedly a case of chronic or subacute pancreatitis. In either case, cholecystostomy is indicated. I do not approve of cholecystgastrostomy as an emergency measure. This can be done later if an external biliary fistula remains for two months.

The gall-bladder is not enlarged ; indeed, it is thick-walled and may be fibrotic, small, or full of stones. Proceed at once to palpate the common bile-duct. A stone of fair dimensions is felt in the common

Fig. 124.—Stone impacted in the supraduodenal portion of the common bile-duct. Incision of the duct overlying the stone.

bile-duct. Grasp the stone between finger and thumb (*Fig.* 124) and do not leave go, for the stone may slip out of reach. Let the assistant

retract as necessary, until you can see what you are holding. Incise
the common duct longitudinally on to the stone, and release it. Deli-
cately pick up the cut edges of the common duct. Mop away the
bile which continues to flow. If circumstances permit, pass Desjardins'
forceps upwards and downwards within the lumen of the duct, and
make sure that no other stones are within. Close the opening in the
common duct about a drainage tube (*see* later, p. 145).
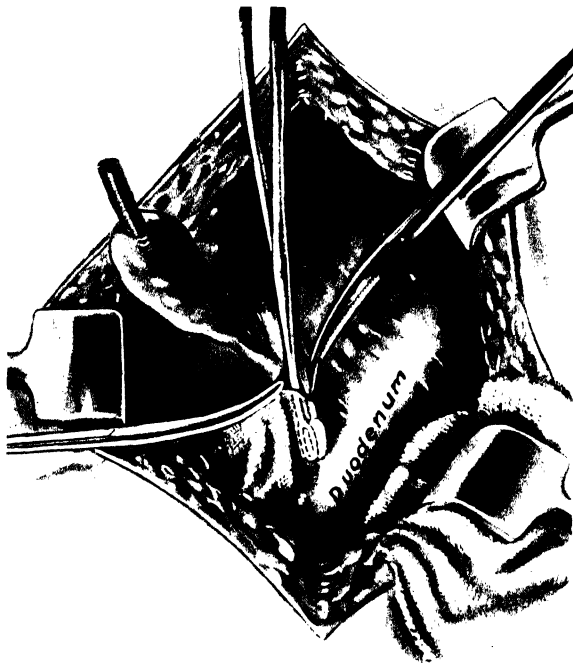
The cause of the obstruction is doubtful. An obvious calculus
cannot be palpated in the common duct. Open the gall-bladder
and remove calculi, if present. Unless there is a copious free flow
of bile from the gall-bladder, cholecystostomy will not remedy the
obstruction. Focus your attention upon the common bile-duct.
When the common duct is obstructed it is enlarged, perhaps to the
size of a finger, sometimes even larger. If doubt arises as to whether
the structure under observation *is* the common bile-duct, take a
hypodermic syringe, puncture the structure, and aspirate. Bile
is unmistakable. 'White bile' looks like mucus. In either case,

the presence of bile or mucus in the syringe is conclusive evidence that the doubtful structure is none other than that which we seek.
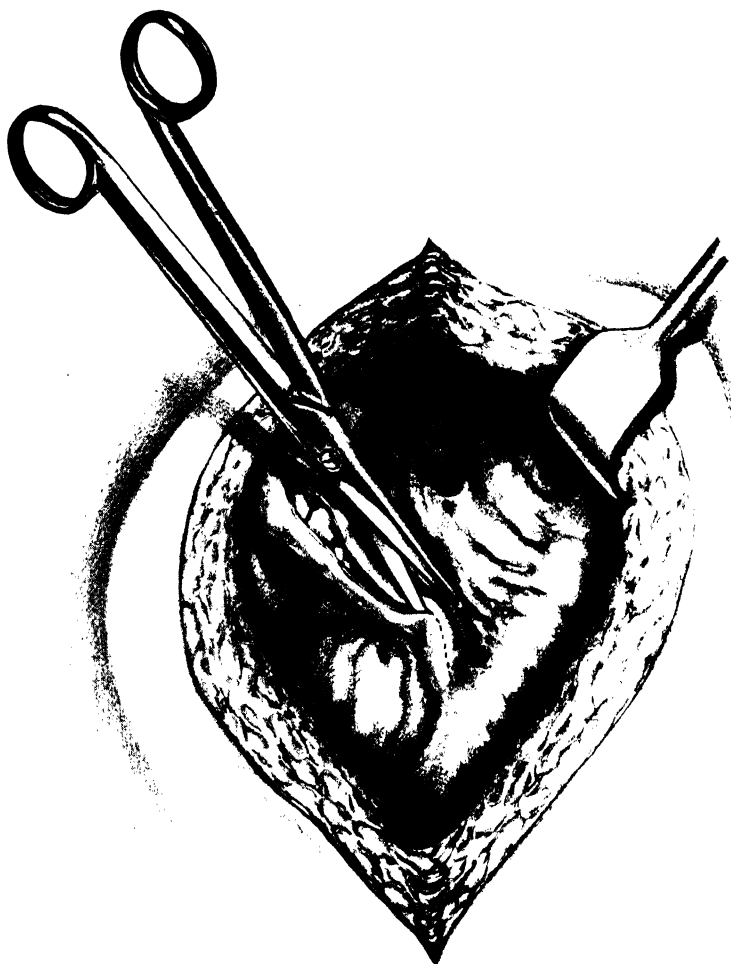
Fig. 126.—Entering the common bile-duct by way of slitting the gall-bladder and the cystic duct.

Being now entirely satisfied that we are dealing with an enlarged common bile-duct, choledochostomy can be performed through a longitudinal incision about half an inch long. The interior of the duct is explored deftly with special forceps (*Fig.* 125), remembering

that a likely place for an elusive obstructing calculus is near the ampulla of Vater. If the patient is standing the operation poorly, the only wise course is to conclude by drainage of the common duct (*see below*). Before leaving this subject it may be helpful to describe a method of entering the common bile-duct which I have used a number of times with great satisfaction. The method is applicable only to a certain type of case, one which, in my experience of obstruction to the common duct, is fairly common—the gall-bladder is small, the cystic duct is short and opens into the common duct without convolutions. The gall-bladder and cystic duct are slit down as shown in *Fig.* 126, until the common bile-duct has been entered. After extract-
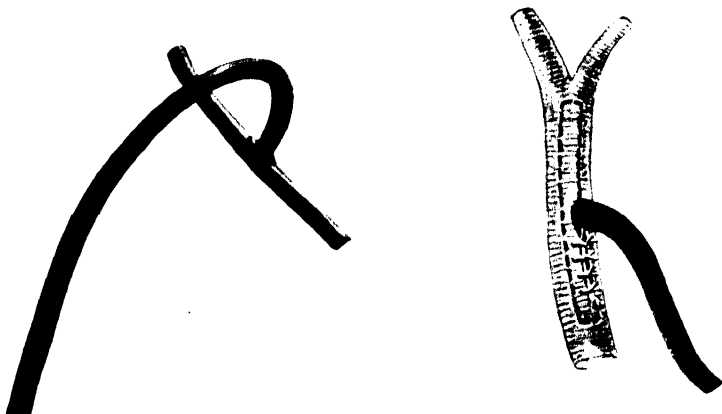
Fig. 127. T-tube for drainage of the common bile-duct.

ing calculi from the bile-passages, the common duct, cystic duct, and gall-bladder can be refashioned by a simple continuous suture. If the lumen of the cystic duct is adequate, drainage of the common duct can be carried out via the gall-bladder. In most cases, however, it is safer to employ orthodox drainage of the common duct in addition to cholecystostomy.

Drainage of the Common Bile-duct.—The T-tube (*Fig.* 127), if available, is very useful. Usually the transverse limbs of the T as supplied by the makers are unnecessarily long ; they should be pruned. *Fig.* 128 will make the technique of closing the common duct about the T-tube clear.

When the T-tube is not available an ordinary drainage tube of suitable dimensions must be employed. It is valuable to have the

E. S. 10

tube armed with a stitch of fine catgut with a small round needle
ready threaded on each end (*Fig.* 129). The tube is passed into the
common duct in an upward direction, and it is stitched in place. The
opening in the duct is closed about the tube with interrupted stitches.
After a drainage tube has been inserted into the common bile-duct
omentum should be so arranged about the tube as to favour the
formation of a tract from the opening of the common bile-duct to
the surface. It is usual to bring a tube draining the common duct
out through the abdominal incision, but the first consideration should
be that the tube makes a straight line to the anterior abdominal
wall, and a stab incision for the exit of the tube may better suit a
particular case.

After-treatment.—The continuous administration of saline and
glucose has a remarkably beneficial effect. By its use I have seen
deeply jaundiced patients, when the obstruction has been relieved,
'washed clear' in forty-eight hours. If this remarkable improvement
in the colour of the patient is not manifest within three days of the
operation and the saline has been flowing satisfactorily, it is probable
that the obstruction has not been relieved. There should be no hurry
to remove the tube in the common duct. After two weeks, if the
flow of bile is not lessening and the fæces are not coloured satisfac-
torily, an injection of lipiodol down the tube, followed by an X-ray,
will often be helpful in determining whether there is a free channel
from the bile-passages into the duodenum.

SOME POINTS TO BEAR IN MIND IN CONNECTION WITH OBSTRUCTIVE JAUNDICE

1. There is seldom much hurry to operate upon these patients ; on the other hand, they are frequently left unrelieved too long.

2. Unless on clinical palpation of the abdomen the gall-bladder is enlarged unquestionably, operations for biliary obstruction should not be undertaken by the occasional operator if more skilled services are available within forty-eight hours.

3. Operation for the relief of obstructive jaundice should be the simplest possible, but it must be adequate.

4. Cholecystectomy in addition to the relief of the obstruction is uncalled for, and if attempted in the presence of jaundice the life of the patient is being endangered unnecessarily.

5. The essential aim of the operation is to relieve the obstruction. A worthy objective is at the same time to remove the cause of that obstruction should it be possible.

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CHAPTER XI

OTHER EMERGENCY CONDITIONS IN THE UPPER ABDOMEN

ACUTE PANCREATITIS

ACUTE pancreatitis varies considerably in severity. In its most acute forms a dusky cyanosis is seen about the face and neck of the patient. In all probability this phenomenon is a manifestation of toxæmia caused by the absorption of protein metabolites. The deeper the cyanosis the graver is the prognosis. Until a few years ago the correct pre-operative diagnosis of acute pancreatitis was unusual. At the present time, since the clinical features of the condition are better understood, a positive diagnosis often can be made.

Fig. 130.— Loewi's test: positive reaction. (Photograph taken twenty hours after an operation for acute pancreatitis.)

Of the many laboratory tests which aid in the diagnosis of pancreatitis nothing will be said. The acute abdominal catastrophe as often as not comes under observation for the first time late at night, when laboratory facilities are at a low ebb. Even if these facilities are at hand, by the time a report has been received it is, as a rule, merely a matter of academic interest as far as an urgent diagnosis is concerned.

Loewi's test (Fig. 130) is in a different category. It can be performed by the clinician at the bedside. There are some who suggest that the half-hour's delay whilst awaiting the result of the instillation is not justifiable in urgent abdominal cases. On the other hand this half-hour can be employed very profitably by treating shock and getting the patient into the best possible condition for operation. Saline can be administered, and if the decision has been reached that

the lesion is an upper abdominal one and requires 'immediate' operation, there is no objection to giving the patient morphia. Loewi's test, whilst being very useful, is by no means absolute. For instance, I have seen full dilatation of the pupil after the instillation of adrenalin in a patient suffering from pneumonia.

Prognosis.—Recovery from acute pancreatitis is not unknown, but it is safe to say that those cases which recover by medical, that is expectant, treatment, would also recover by operative treatment, whilst some of those who die without operation might have been saved had they been submitted to operation (Deaver). The prognosis of acute pancreatitis is always grave and at the present time the mortality of cases upon which a prompt operation has been performed is a little under 50 per cent. Improvement can be hoped for with earlier diagnosis and more thorough drainage of the peripancreatic tissues.

Treatment.—Instant drainage is the procedure indicated—drainage of the lesser and greater sacs of the peritoneum, if they are involved, but, what is probably equally important, is adequate drainage of the peripancreatic cellular space.

The anæsthetic is a matter of even more than usual importance, for these patients are often obese and very toxic. The choice must be left to individual judgment.

The incision should, if possible, be one which gives good access to the gall-bladder (*see* Chapter X).

On opening the peritoneum blood-stained fluid will be met with; but in early cases this is limited to the lesser sac, in which case red-coloured fluid will be visible in the great omentum immediately below the greater curvature of the stomach. In addition, areas of fat necrosis are often seen in the omentum and peritoneum. The presence of fat necroses and blood-stained fluid in the peritoneal cavity are pathognomonic of acute pancreatitis. *When the patient's condition is desperate* the operation must be limited to drainage of the lesser sac (*Fig.* 131), combined with suprapubic drainage if there is considerable free fluid in the general peritoneal cavity.
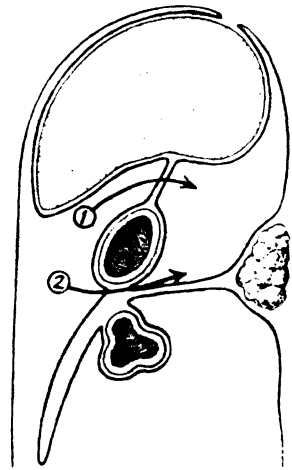
Fig. 131. Routes for draining the lesser sac. (1) Through the gastrohepatic omentum; (2) Bet̲̲̲̲h and the co̲ n. (2) is th̲ more usual method. (1) ̲ useful when ̲ certain am̲ unt of gastroj̲

When the patient will stand a somewhat more prolonged operation.
It is reasonable to expect an improvement in results which at the
present time are unsatisfactory if, in addition to the above, the seat
of the inflammation is drained adequately. I am much impressed by
Haynes' method of draining the peripancreatic tissues. The head of
the pancreas lying in the curve of the duodenum is exposed by lifting
up the transverse colon and omentum (*Fig.* 132). It is important to
pack off the field of operation thoroughly, in order to avoid soiling the
general peritoneal cavity. At the lower part of the head of the pancreas
there is usually a small area of peritoneum which is practically free

Fig. 132.— Drainage of the peripancreatic tissues. The index finger is shown
freeing the posterior surface of the pancreas. The fingers of the other hand
rest on the front of the pancreas and act as a guide while the burrowing is
in progress.

from blood-vessels. At this point the peritoneum is incised and a
hæmostat is introduced. The dissection is carried out between the
pancreas and the duodenum. The line of cleavage between these
structures is opened most carefully in order not to wound the duodenal
or pancreatico-duodenal vessels. When this space has been opened
sufficiently to admit the index finger the remainder of the dissection
is made entirely with the finger. It is easy to open up the space
immediately behind the head, body, and tail of the pancreas. It is
better to open too much than too little of this space. If the finger is
kept as close as possible to the posterior surface of the pancreas the

important vessels which lie in the neighbourhood will not be endangered. It is helpful to steady the region of the pancreas from in front with the fingers of the opposite hand. A good-sized soft drainage tube is then passed into the cavity (*Fig.* 133). The transverse colon is brought down to its normal position and the omentum is draped around the drainage tube carefully. When closing the abdominal wall the drainage tube is brought out at an easy curve to prevent kinking. The tube is kept in position for five or six days, when shortening is commenced.

Cholecystostomy is a rapid and simple procedure. It is doubtful if it is of much value in draining the common duct. Nevertheless, there is much to be said in favour of it as a supplementary therapeutic measure in acute pancreatitis. Removal of gall-stones and cholecystostomy should be performed in every case when the condition of the patient will allow.
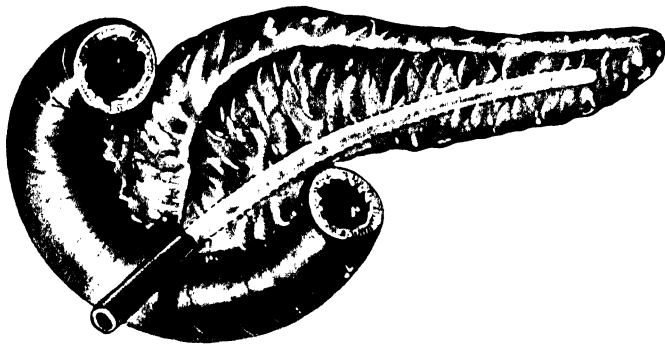
Fig. 133. Drainage tube *in situ* behind the pancreas showing the relationships to the duodenum. (*After H. Haynes.*)

Post-operative Treatment. Continuous intravenous saline will most certainly be indicated during the immediate post-operative period.

The escaping pancreatic juices tend to digest the abdominal wall and sutures contained therein. ' Burst abdomen ' is not an uncommon complication, and should be especially guarded against by suitably supporting the incision. Digestion of the skin around the wound may be effectively prevented by smearing it with a mineral ointment (paraffinum molle) *containing* 2 *per cent of hydrochloric acid,* which renders the ferments impotent.

Diet. In the early stages feeds should be pancreatized. Until the diastase content of the urine has fallen to normal, fats should be withheld as far as possible.

Pancreatic Asthenia. Whipple has drawn attention to a condition which he has named pancreatic asthenia. It occurs between the

second and ninth day after operations upon the pancreas, and lasts for a varying period. Of his 40 cases, 7 followed operations for acute pancreatitis. Weakness is the chief complaint ; the asthenia in some cases approaches that of Addison's disease ; there is a mask-like expression, a drawling voice, muscular relaxation, and a tendency to salivation. The only treatment of permanent value is blood transfusion. It is curious to note that the request for bizarre dishes is often the first indication of a subjective improvement.

Recurrence. Acute pancreatitis is often the culmination of a series of attacks of subacute pancreatitis. Acute pancreatitis itself may recur. I was able to trace over a long period the history of *Case 2* in my series, which is instructive.

The patient was a brewer's drayman. In 1907, at the age of 36, he was seized with acute abdominal pain. He recovered sufficiently to attend the medical out-patient department of the London Hospital. A diagnosis of acute alcoholic gastritis was made. He was given medicine, and discharged a few weeks later as cured. In 1910, after drinking a glass of water, he was seized with severe pains similar to the last. He vomited several times, and was admitted to the hospital. On examination, tenderness was present over the gall-bladder area. The symptoms abated, and he was discharged. In February, 1924, he had a third severe attack while rolling barrels. Pain was so acute that the patient collapsed. The brewery at which he worked was immediately opposite the hospital, and I saw him within an hour of the onset. He was profoundly shocked, cyanosis was present, and abdominal rigidity entirely absent. A diagnosis of acute pancreatitis was made. After anti-shock treatment had been instituted the abdomen was opened. Fat necrosis was general ; the pancreas was purple and œdematous ; the gall-bladder was distended, but no stones were present. Cholecystostomy was performed, and the lesser sac drained. The patient recovered and returned to work.

In July, 1924, he was seized with a fourth attack. He was admitted cyanosed and quite pulseless, although conscious. He stated that it was exactly the same pain, and it began in the middle of the night forty-eight hours before. He did not respond to anti-shock treatment, and died three hours later. The necropsy revealed advanced hæmorrhagic pancreatitis.

PYLEPHLEBITIS (PORTAL PYÆMIA)

Although pylephlebitis cannot be ranked as an emergency, the majority of cases arise as a complication of acute appendicitis. It is therefore a relevant subject to discuss here.

If a swinging temperature and rigors occur in the course of appendicitis, pylephlebitis is one of the first things to be thought of. It is usually an easy matter to eliminate the other possible causes of the intermittent pyrexia, with one exception, subphrenic abscess. A slight icteric tinge and rigors strongly favour the diagnosis of pylephlebitis. In cases of doubt an examination of the movements of the diaphragm under the fluorescent screen is perhaps the most helpful of the auxiliary methods of differential diagnosis, but it is by no means infallible.

A honeycomb of abscesses distributed through the liver substance (*Fig.* 134) is the underlying pathology of most cases of pylephlebitis : a state of affairs which is necessarily fatal. Little wonder, then, that the condition is generally conceded to be hopeless. True, most cases end fatally ; nevertheless, so long as the patient has a good hold on life we should assume that he is to be an exception. The exceptional case escapes death in one of two ways : (1) Eminent pathologists are of the opinion that resorption of small abscesses of the liver sometimes takes place : (2) A localized collection of pus may form, d of which is usually followed by recovery.

Resorption.

A man of 36 was operated on for acute gangrenous unperforated appendicitis. On the fourth day his temperature rose to 102 , and there were occasional rigors. This continued for seven days. During this time repeated examination of the abdomen and thorax was made with negative result, except for tenderness in the right hypochondrium. The screen examination was reported upon as being in favour of subphrenic abscess. Laparotomy revealed nothing except an enlargement of the liver. He was given intravenous mercurochrome daily for three days, with immediate benefit. The temperature after this remained normal, and convalescence was thenceforth uneventful.

The above case may be looked upon as a possible example of resorption. It was the first case in which I tried intravenous mercurochrome. Nevertheless, in four subsequent well-established examples of pylephlebitis mercurochrome did not prevent the usual course of the disease.

The Question of Operation.

Laparotomy in pylephlebitis is indicated. There is no immediate hurry, but if the liver is enlarged, operation should not be delayed unduly. In the first place, if the

hand can be passed between the liver and the diaphragm, the exist-
ence of a subphrenic abscess can be eliminated at once.   From time

Fig. 135.   Pylephlebitis. A patient in the sixth week of the condition, showing
the extreme emaciation.   There were multiple abscesses in the liver.   The
largest abscess cavities were drained.

to time a localized abscess of the liver has been found and dra
Successful cases of this kind have been reported by Brogden, Barnes
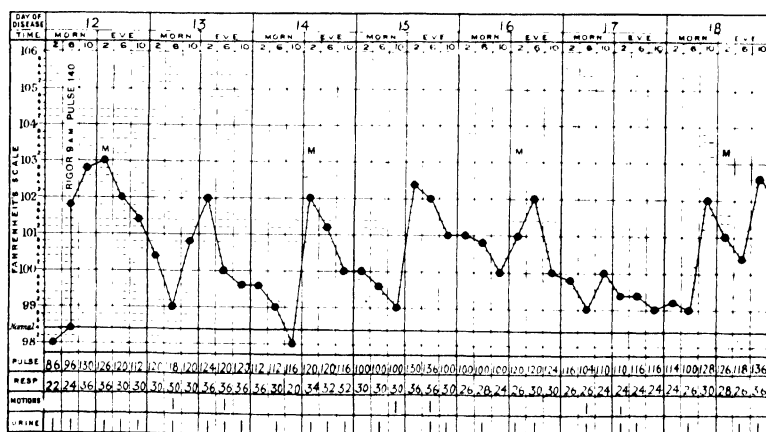
Fig. 136.—Temperature chart of patient shown in *Fig.* 135.   M. Intravenous
chrome.

and Pearson, and others.   In a case successfully operated upon by

Mr. Littler Jones of Liverpool, witnessed by the writer, two abscesses in the right lobe of the liver were drained. These were a sequel of suppurating piles. If the whole liver is studded with small abscesses, there is nothing to be done surgically, but should there be one or two main abscess cavities, these should be drained (*Figs.* 135, 136).

Drainage of a Liver Abscess. Unless deeply placed, the abscess can be recognized by palpating the liver when the abdomen has been opened; there is an elevation on the liver surface and induration. An aspirating syringe is used to confirm the suspicion after the area has been most carefully packed off. To drain the abscess, sinus forceps are inserted. *The finger should not enlarge the opening, nor attempt to break down loculi as is done in abscesses in other situations,* for this will cause tearing of the liver and serious bleeding. If the abscess is in the right lobe and pointing laterally, the transcostal route should be employed. If pointing anteriorly, the drainage tube is brought out through the laparotomy wound, or, what is preferable, through a special stab. It is very necessary to erect a barrier of omentum to shut off the general peritoneal cavity. It must also be remembered that pus will ooze out alongside the tube and infect the space between the liver and the costal wall. Drainage of this space must also be provided for. The patient should be nursed in the semi-Trendelenburg position for several days to ensure that pus does not gravitate downwards into the general peritoneal cavity. After this time adhesions will have formed and he can gradually be propped up.

The Prevention of Pylephlebitis. Hæmorrhoids should never be removed when in an acutely inflamed state.

Acute appendicitis is the commonest cause of pylephlebitis —which, even so, is a very rare complication. It is necessary to have seen an otherwise favourable case of appendicitis slowly succumb to the ravages of portal pyæmia to realize fully that it is worth while making some systematic effort to prevent its occurrence.

Ligature of the Ileocolic Vein. Ligature of the ileocolic vein as a preventive measure was advocated and practised by Guster many years ago. In an excellent paper by Colp (1927) attention has been again drawn to the importance of this measure. A patient with appendicitis, who has rigors early in the attack and before operation, may be fairly assumed to be in imminent danger of pylephlebitis. It is in such cases that ligature of the ileocolic vein is indicated. The vein should be ligatured before the appendix is removed. The cæcum is drawn well out of the wound and the superior ileocæcal angle sought. The vein is located and traced upwards about two inches, where it will be found to be joined by other cæcal branches. Using a

Watson Cheyne dissector, the vein is isolated from its peritoneal covering (*Fig.* 137), and, taking care not to include the artery, is ligatured. I have practised this measure on several occasions. In each case the patient had rigors prior to the operation. All made a smooth recovery, and possibly were saved from portal pyæmia.

Intravenous Mercuro-chrome.—The patient with a gangrenous appendix is given a dose of this drug intravenously at the close of the operation. I have carried this out for some time as a routine, and believe that it has done good. There have been no untoward effects attributable to the drug.

Fig. 137. The prevention of pylephlebitis. Isolating the ileocolic vein preliminary to passing the ligature.

SUBPHRENIC ABSCESS

Subphrenic abscess is much rarer than in former days. Important contributory factors in lowering the incidence of this grave complication are : (1) The adoption of Fowler's position ; (2) The abandonment of abdominal lavage ; (3) The use of the flank slab drain when drainage is necessary in retrocaecal appendicitis.

The diagnosis is usually difficult. "Signs of pus somewhere, signs of pus nowhere else, signs of pus *there* " was Barnard's aphorism. In suspected cases a radiological examination to trace the level and movements of the diaphragm is to be recommended. It is advisable also to get a medical opinion on the lungs. In a large percentage of cases of subphrenic abscess there are signs in the corresponding base of the lung. All things being equal, a pleural effusion or consolidation of the base of the lung on the corresponding side helps, rather than hinders, the diagnosis of subphrenic abscess.

Treatment. —In a minority of cases the diagnosis is proclaimed by a swelling either in the loin or anteriorly. Drainage in these cases is a simple matter. When the swelling is anterior an incision is made over its centre, but the drainage tube should be brought out through

a stab wound as far posteriorly as is feasible, and the original incision sewn up. When the swelling is posterior the abscess can be drained admirably by making an incision over the 12th rib, which is resected A *transverse* incision (not along the line of the rib) is made in the bed of the rib at the level of first lumbar vertebra (*Fig.* 138). This traverses the diaphragm and opens the subphrenic space.
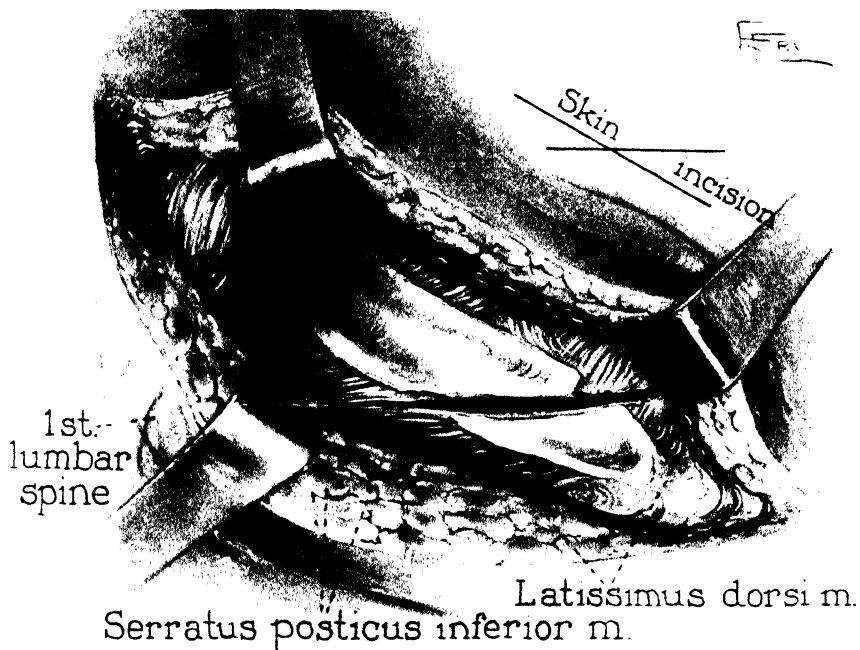
Needling for a Subphrenic Abscess. I have found both unsatisfactory and dangerous. When the signs point strongly to the diagnosis and (which is usual) there is no swelling. I think the better plan is to perform transpleural drainage *in two stages.* If necessary I would rather explore the upper abdomen under local anaesthesia as for cholecystostomy (*see* p. 127) than needle for a subphrenic abscess.

Transpleural Drainage. 1*st stage.* Under local anaesthesia resect portions of the 8th and 9th ribs in the posterior axillary line. Pack the cavity firmly to promote adhesion between the layers of the pleura. Wait two, three, four, or even five days if the patient's condition will allow.

Transpleural drainage, 2nd stage (gas and oxygen anaesthesia).—

Unless it has been possible to wait four or five days, insert deep sutures in such a way as to cut off a circle of the pleural cavity (*Figs.* 139, 140). By this method the diaphragm is sewn to the periosteum and intercostal muscles, and sandwiched between these substantial strata is the delicate pleura and its potential cavity. In the centre of this circle an incision is made right through to the subdiaphragmatic collection of pus, and a good-sized drainage tube inserted. The skin is then approximated about the tube.

dhren   Pe
been resected.   A ring of interrup
              diaph   > the ir
I n: i

th

Fig. 140. Transpleural drainage of a subphrenic abscess. Coronal section to illustrate the method of isolating the pleura before opening the abscess.

The patient is nursed on his right side as many hours a day as possible. The tube should remain *in situ* for a longer time than is customary when coils of intestine are in the proximity.

Prognosis. As might be expected, the mortality is highest in those cases in which the transpleural route has to be used. This is largely due to the fact that the absence of a palpable swelling makes the diagnosis of subphrenic abscess so difficult that drainage is often carried out too late. Fifield and Love collected 59 cases of subphrenic abscess submitted to operation, with the following results :

OPERATION	O. OF CASES	MORTALITY (Per cent)
Transpleural drainage		44
Drainage through anterior abdominal wall		24
Drainage through loin		17

With a two-stage operation, the first stage being performed under local anæsthesia, and by eschewing needling, the mortality of transpleural drainage should be reduced.

INTRAPERITONEAL RUPTURE OF A HYDATID CYST

In countries where hydatid cysts are rare, a correct pre-operative diagnosis of ruptured hydatid is improbable. In addition to symptoms of an acute abdominal catastrophe, urticaria and pruritus are frequently present. Eosinophilia in the circulating blood may be the means of clinching a tentative diagnosis.

Dew's Case.

E. B., a male of 45, was admitted in a state of severe shock, with a history that while he was lifting a weight he suddenly collapsed. The abdomen moved fairly well on respiration, but he was tender and rigid over the gall-bladder region. There was dullness in the flank as far medially as the umbilicus, and it moved with change of position. The diagnosis of visceral rupture was made, and the patient prepared for immediate operation.

The peritoneal cavity was found to contain much hydatid fluid and many daughter cysts of all sizes. A large multilocular cyst of the right lobe of the liver, adherent to the colon and gall-bladder, was found. This had a large opening on its posterior lateral aspect, at which point rupture had occurred. This cyst was evacuated and drained. The pelvis was then drained suprapubically by a large tube, after removing fluid and cysts as far as possible. The patient, for ten days after the operation, had a temperature of 102·5, rapid pulse, cough, dyspnœic attacks, and some delirium at night. It is probable that these symptoms were mainly anaphylactic in nature. For six weeks small cysts occasionally appeared through the lower incision, but after being in hospital for two months he was discharged, with instructions to report regularly, and with a warning that probably secondary pelvic cysts would develop in a few years.

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CHAPTER XII

FOREIGN BODIES IN THE FOOD PASSAGES

REMOVAL OF A FOREIGN BODY FROM THE ŒSOPHAGUS BY ŒSOPHAGOSCOPY

IT is important to confirm. whenever possible. the presence of the foreign body by X rays (*Fig.* 141). This should be done just prior to the operation. for if some time has elapsed since the X-ray. the foreign body may have moved onwards.

Before commencing œsophagoscopy. review the apparatus (*Fig.* 142). See that the lamps are working : observe the forceps. and see that the points engage : have a number of small pieces of gauze of a correct size to pass down the œsophagoscope in readiness these are to mop out secretion.

The patient is anæsthetized. and the anæsthetic continued by nasal apparatus (a 'fool-proof' Junker). Evipan anæsthesia is often sufficient.

Fig. 141.—Coin impacted in he upper part of the œsophagus.

Position of the Patient : Chevalier Jackson's Position. The position of the patient for œsophagoscopy is a most important consideration. The head of the table is let down completely. and the patient's head and

Fig. 142. Œsophago ope   al f

neck are supported entirely by the seated assistant (not the anæsthetist) in the manner shown in *Fig.* 143. This allows the head to be held gently, but firmly, in any desired position. Note the following most carefully : *During the passage of the œsophagoscope the patient's*

head should not be extended ; the assistant keeps the head well flexed. It is only when the instrument is within the thoracic portion of the œsophagus that the head is lowered. Meticulous observation of this rule very materially aids œsophagoscopy.

Fig. 143. Chevalier Jackson's position for œsophagoscopy. The head of the patient is supported entirely by the hands of the seated assistant.

When a first assistant is not available the head may rest on the operating table, but it should be flexed slightly by a flat pillow.

Fig. 144. Removing a coin from the œsophagus. It is preferable to have the head supported by an assistant instead of the head-rest and pillow used in this case.

Fig. 144 shows an œsophagoscope being introduced with the patient in this position.

Technique. — The mouth is opened with a gag inserted on the left side, and the tongue is drawn out by the anæsthetist. The outside of the œsophagoscope is smeared with a little sterile glycerin.
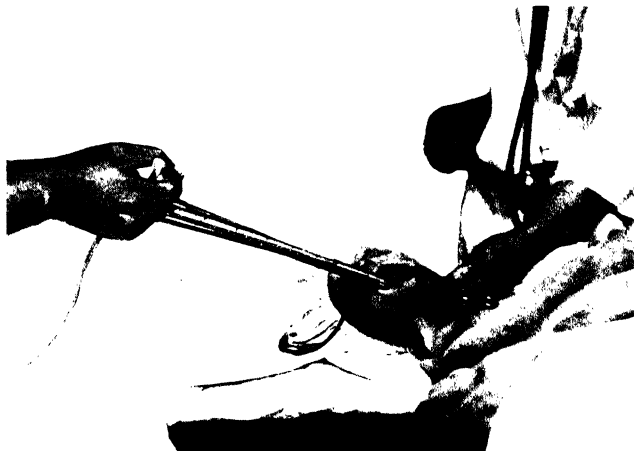
Fig. 145. Introducing the œsophagoscope. First stage. Negus's œsophagoscope being used.

The operator stands. With the handles of the instrument directed upwards, the œsophagoscope is passed along the right side of the tongue until the posterior pharyngeal wall is reached (*Fig.* 145). A lifting motion is imparted to the beak of the instrument, and this will bring the right arytenoid cartilage into view. The advancing tip of the œsophagoscope is lifted over this structure and the instrument directed somewhat towards the middle line. It glides on for a short distance, then comes to a stop; this is the crico-pharyngeal constriction (*Fig.* 146). A little steady pressure with a lifting motion imparted to the distal end of the instrument by the left thumb within the mouth overcomes the obstruction. The instrument is now within the thoracic portion of the œsophagus, along which it passes with comparative
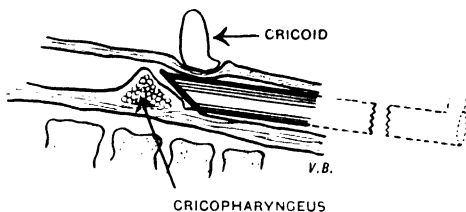
Fig. 146. Passing the cricopharyngeal constriction, the most difficult part of œsophagoscopy. The importance of keeping the handle of the instrument uppermost during the manipulation can be seen.

ease. Directly the crico-pharyngeus is passed the head may be lowered somewhat, and the operator, who up to this time has been standing,

takes a seat low enough to allow his eye to peer down the œsophago-
scope without inconvenience.

If an X-ray has been taken, we shall know in which part of the
œsophagus to expect the foreign body, and the instrument will be
advanced slowly when ap-
proaching this region. A coin
is sometimes buried in food.
When the object is seen (*Fig.*
147) it must be manœuvred
with the closed forceps, or by
moving the œsophagoscope
slightly backwards and for-
wards, until an edge suitable
for grasping presents. The for-
ceps then seizes the body, and,
still grasping it, the forceps,
œsophagoscope, and foreign
body are removed *en bloc*.

In a small series of cases,
which include two sets of false
teeth and more than a dozen
coins, I have used only the
simple alligator forceps (*Fig.* 142) and have found them perfectly
satisfactory.

Fig. 147. A penny in the œsophagus as se
through an œsophagoscope.

Some Difficulties of Œsophagoscopy.

Light Anæsthesia. If the patient starts gagging, the anæsthetic
not deep   ough, and it is dangerous to proceed. Remove the
instrument, and when the patient is fully anæsthetized,
start again.
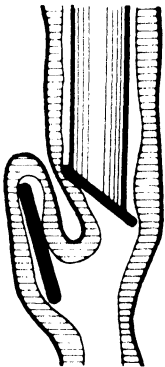
Fig. 148. Coin
hidden by a fold of
mucous membrane

The Foreign Body is not Visible. It is possible
for a foreign body to be hidden by a fold of mucous
membrane (*Fig.* 148), and this is most likely to occur
just distal to the cricopharyngeus. If, after an
adequate search, the object cannot be seen, remove
the œsophagoscope, and, having reinserted the instru-
ment, scrutinize the whole course of the œsophagus
once more. On one occasion a second search failed
to reveal a denture which had been swallowed. The
patient had been X-rayed elsewhere earlier in the
day, and brought a film showing the denture in
the mid-œsophagus. Still under the anæsthetic, the
patient was moved to the X-ray room, and there
screened. The teeth were in the stomach. On
return to the theatre the denture was removed by gastrotomy. This

emphasizes the wisdom of not accepting X-ray evidence unless it is of very recent origin.

The Problem of the Safety-pin. — An open safety-pin with the point downwards offers no particular difficulty. The coiled spring is seized, and the pin drawn into the open mouth of the tube (*Fig.* 149). In the case of a small safety-pin with the point upwards, version may be tried, but always, and only, in the direction which will cause the point to trail (*Fig.* 149). Once the coiled spring is uppermost it can be
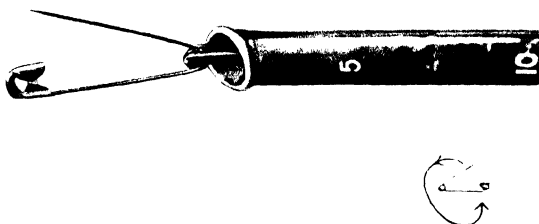
Fig. 149.—A safety-pin must always be withdrawn spring first. In the case of a small pin pointing in the wrong direction version may be attempted, but always in the direction shown in inset — i.e., the point must trail.

drawn into the œsophagoscope. The open large safety-pin is a difficult problem. Version must not be attempted. It should be gently pushed downwards into the stomach. Skilled œsophagoscopists can perform intragastric version, and then remove the pin endoscopically. If I had to deal with such a case I should rest content with pushing the safety-pin into the stomach and then performing gastrotomy.

REMOVAL OF COINS AND SIMILARLY SHAPED FOREIGN BODIES FROM THE UPPER FOOD-PASSAGE BY MEANS OF A COIN-CATCHER*

The coin-catcher (*Fig.* 150) is not a dangerous instrument if it is used in conjunction with an X-ray screen. An anæsthetic is administered, the patient being on the X-ray couch. A gag is inserted

Scale ⅖
Fig. 150. A coin-cat

and the coin-catcher is passed into the oropharynx. The X-ray screen is now placed over the neck and upper part of the thorax. Lights are switched out and the object is readily seen on the fluorescent

* Mr. C. H. Carroll, Assistant Aural Surgeon to the Devon and Exeter Hospital, has kindly supplied most of the details of this method.

screen, often at the level of the suprasternal notch. The coin-catcher
is gently pushed onwards, the index
finger in the pharynx acting as guide,
until the extremity of the instru-
ment is seen to pass the object. As
soon as the hooked extremity has
passed the lower edge of the coin, the
catcher is gently withdrawn and the
coin is thus automatically engaged
(*Fig.* 151). Immediately the coin is
on its upward journey the patient's
head is lowered over the table. Lights
are switched on and the coin is
retrieved in the pharynx by the await-
ing fingers.

The coin-catcher is useless for
foreign bodies in the trachea or bronchi,
and never should an attempt be made to
use it for any other purpose than for
the removal of a flattened object in the
pharynx or upper part of the œsophagus.
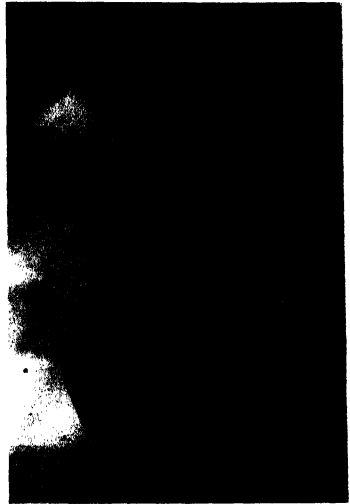
INGESTED FOREIGN BODIES IN THE INTESTINE AND STOMACH

A foreign body has been swallowed. The problem before us has
been simplified by X rays, but there remains a considerable amount
of judgement to be displayed in deciding whether the foreign body
should be left, to see if it will be voided, or be removed by
operation.

Usually small coins and rounded objects are passed without diffi-
culty. If there is any irregularity of contour it is customary to
prescribe a bulky diet, such as porridge and suet pudding, in which,
it is hoped, the foreign body will become entangled. Purgatives are
to be avoided. The passage of the foreign body along the alimentary
canal is watched by repeated radiographs.

When it has been decided to see if the foreign body will pass,
there is no better method than to administer Normacol, two or three
drachms every six hours, until the object has been expelled. Nor-
macol is a proprietary vegetable laxative which swells enormously
when it comes in contact with water. It forms in the alimentary
canal a gelatinous mass in which the foreign body is likely to
become entangled.

Tooth plates with hooks are better removed without delay.
Whether to remove a pin, or wait, is a matter for individual judge-
ment. On several occasions I have administered Normacol and the

pin has been passed, but if its passage is delayed at any point for several hours, other things being equal, I should certainly recommend operative removal.   Macewen records a case of a soldier who died of general peritonitis from a pin piercing the cæcum.

Technique of the Removal of a Pin from the Gut.—After isolating carefully the segment of gut with pads, by manipulation the point of the pin is made to protrude through the intestine wall.   As soon as the point appears it is grasped with a hæmostat ; the fingers do not touch the infected metal.   A purse-string is inserted around the perforation, and with a firm tug out comes the pin (*Fig.* 152).   The purse-string suture is then tied.

In the Duodenum.—The duodenum is a favourite place for a pin to become lodged.   If the object is in the first or the second parts an attempt should be made to push it back into the stomach, and there to effect extraction, for the stomach is easier to suture than the duodenum.

In the Remainder of the Intestine (*Figs.* 153, 154).   The foreign body may become lodged in any portion of the gut.   The cæcum is a favourite site.   Meckel's diver-
ticulum, when present, is another likely spot ; on one occasion, when operating for general peritonitis, Lindqvist found a sharp fragment of wood piercing a Meckel's diver-
ticulum.

The removal of a foreign body from the gut follows recognized surgical principles.   It suffices to say that the field should be packed off carefully, a clamp should be applied whenever possible to avoid escape of fæces, and the gut sewn up with a purse-string in the case of elongated bodies removed through a minute

Fig. 152.   Method of extracting a pin from the intestine.

perforation.   When it is necessary to make an incision of half an inch or more the hole should be sewn up transversely in two layers.

In the Stomach.—Operation is advised if the foreign body is judged to be too large to pass the pylorus, has failed to pass the pylorus after two days, or is of a dangerously spiked nature.   The upper abdomen is opened and the stomach palpated for the object. When found it is manipulated against the anterior gastric wall, and if of appreciable size, such as a coin, a stomach clamp is slipped

beneath it. After arranging abdominal pads, a small incision is made into the stomach and the foreign body extracted. The stomach is closed in two layers. Within reason the larger the foreign body the smaller can be the incision for its removal. I extracted a dinner fork from the stomach of a convict through a two-inch incision.

In the case of a baby with an open safety-pin in its stomach Broster passed a stomach tube, and, after opening the abdomen, manipulated the point of the safety-pin through the end of the tube, and closed the safety-pin. The anæsthetist then withdrew the tube and the pin. There seems little advantage in this ingenious method.

Fig. 153. Skiagram of a nail impacted in the colon at the hepatic flexure, removed by operation.

Fig. 154. Skiagram of a blanket pin in the transverse colon. Removed by technique shown in *Fig.* 152.

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CHAPTER XIII

INTRA-ABDOMINAL INJURIES

SOME GENERAL PRINCIPLES

IN cases of intra-abdominal injury it is generally unwise to delay opening the abdomen if an intraperitoneal lesion is even suspected. An injury to the bladder or kidney can be eliminated by the passage of a catheter. If the urine withdrawn is clear, it is good presumptive evidence that the urinary organs have escaped serious injury. This preliminary step should never be omitted. When a patient has had a blow upon the abdomen and there is suspicious rigidity, it is far better to explore than to wait until the diagnosis is certain.

If it has not been possible to make a precise diagnosis, a small mid-line upper abdominal incision is made. Small, because, if necessary, it can be readily enlarged ; small, too, because if it is found to be an unsuitable avenue of approach, it may be the more readily closed ; upper abdominal, because the spleen, liver, duodenum, gall-bladder, and most of the small intestine and the transverse colon can be inspected through this incision. The small intestine is ruptured ten times more often than the large.

Traumatic Hæmoperitoneum. On opening the abdomen, *if blood and blood-clot* are in evidence, survey the situation rapidly as follows. Usually the source of the hæmorrhage is soon apparent : —

1. Palpate the spleen.
2. Palpate and inspect the under surface of the liver.
3. Pass the hand over the convex surface of the liver.
4. Examine the mesentery. This can be done by lifting out one or two coils of small intestine and observing the inferior and left aspect of the mesentery, and then passing the finger upwards and downwards over the surface. Even small tears near the intestinal border will be detected in this way.
5. Palpate the kidneys (intraperitoneal rupture is very exceptional).
6. Re-examine the spleen, paying special attention to its pedicle.
7. Pass the hand into the pelvis. A tear in the broad ligament was detected at this stage in one obscure case of traumatic hæmoperitoneum. More blood in the pelvis than in the rest of the abdomen suggests a lower abdominal lesion. Nevertheless, pre-operative Fowler's position renders the value of this sign insignificant.

8. Examine the great omentum and transverse mesocolon.

9. Open the lesser sac between the stomach and colon and inspect the pancreas. But an extravasation of blood into the lesser sac will be obvious at a very early stage of the examination.

RUPTURE OF THE SPLEEN

The nature of the violence was quite clear in 32 cases which I reviewed :

Street accident—run over or knocked down by a vehicle	14
Fall on to a projecting object, e.g., the corner of a table	7
Kicked in the abdomen	3
Fall from a height	3
' Buffer ' accident (compression)	3
Fall over handlebars of pedal cycle	2
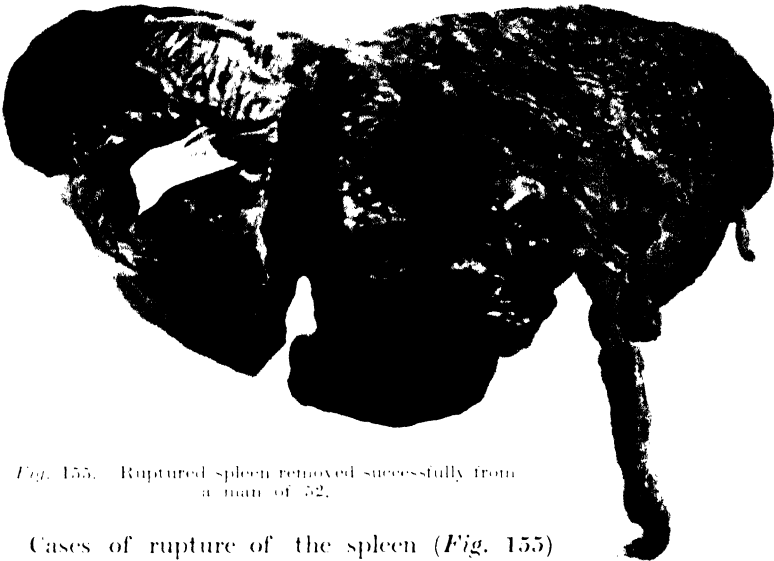
Fig. 155. Ruptured spleen removed successfully from a man of 52.

Cases of rupture of the spleen (*Fig.* 155) are divided into four classes : (1) The patient rapidly succumbs, never rallying from the initial shock : (2) Initial shock—recovery from shock—signs of ruptured spleen : (3) The signs of an intra-abdominal disaster are delayed : (4) Spontaneous recovery.

1. *Rapid Succumbing of the Patient.*—Complete avulsion of the spleen from its pedicle is the type of accident which is most likely to give rise to the symptoms which characterize this group.

A boy, aged 5, was run over, and died two hours after admission to hospital. At necropsy the peritoneal cavity was found to be full of blood, and the detached spleen was discovered lying on the fundus of the bladder.

2. *Shock—Signs of Rupture.*—This is the largest group, and about three-quarters of the total cases belong to it. After the initial shock has passed off there are signs which point to a serious abdominal disaster. It is not always possible to state precisely which organ is damaged, but in the majority of instances the physical signs should point clearly to the spleen as the site of the injury.

3. *The Delayed Type of Case.*—After the initial shock has passed off, the symptoms of a serious intra-abdominal catastrophe are postponed for days, or even weeks.

A navvy, aged 40, was hit in the upper abdomen by a pole. He fainted, but soon recovered sufficiently to walk to hospital, where he was examined and told to report the next day. On the morrow he felt better, and stayed at home. Five days later he was brought in with well-marked signs of internal hæmorrhage, having collapsed at home a few hours before admission. Splenectomy was successfully performed.

Delay of serious bleeding is explained in one of three ways : (1) The great omentum, performing its well-known constabulary duties, shuts off that portion of the peritoneal cavity in the immediate vicinity of the spleen ; (2) A clot seals the rent temporarily ; (3) A subcapsular hæmatoma forms, and later bursts. It is probable that each of these three factors, at one time or another, arrests temporarily serious hæmorrhage.

In the delayed type of case a point worthy of earnest consideration is the baffling friability of the splenic pedicle which is sometimes encountered. 'Friable pedicle' appears to be the peculiar terror of the delayed case, for it was found only in cases belonging to this category. The explanation of this phenomenon is fairly clear. The pedicle, after being surrounded by mildly infected blood and blood-clot for a varying time, itself becomes œdematous, and commences to undergo degeneration. It is thus more likely to be found in those cases in which serious hæmorrhage has been postponed by an omental barrier.

It behoves us, therefore, when dealing with the delayed case, to take particular care to avoid the cutting-out of a ligature. A mass ligature is more likely to cut out than a series of smaller individual ligatures applied by transfixion with a sewing needle close to the spleen. Further precaution is necessary to avoid 'losing' a pedicle which has cut out. C. H. Mayo has immortalized the slipped renal pedicle which, he says, " fairly jumps into the fingers " when nimble fingers promptly follow its retraction into the depths of the wound. If the lieno-renal ligament, with its vascular contents, slips or cuts through, it might be possible to retrieve it by the same means, but there are few of us who would not rather be forewarned !

4. *Spontaneous Recovery.*—From time to time cases have been reported where the spleen was supposed to have been ruptured, and

with rest, and perhaps the administration of some ergot, the patient has recovered. The whole question of the natural repair of a splenic injury is an unimportant one. Nature fails so frequently that we must assume that surgical aid is always needed.

Operation.

The Incision. The left paramedian incision is justly popular for splenectomy. Nevertheless, in an emergency the supra-umbilical midline incision offers certain advantages. Foremost among these is the speed with which the abdomen can be opened or closed. In a doubtful case a useful practice is to make a ' button-hole ' incision immediately above the umbilicus. If the diagnosis is confirmed, the incision can be enlarged rapidly towards the xiphisternum. That the mid-line incision is usually adequate for removal of a ruptured spleen is, I think, well illustrated by one of my patients, a fat, barrel-chested man of 52, from whom the spleen was removed successfully by this route. In those rare instances where more room is required in order to deal with an adherent organ, the incision can be enlarged by a transverse cut to the left. In the delayed type of case H. Dodd has found a transverse incision effective. This incision, while taking longer to close securely, gives excellent access to the splenic pedicle.

Dealing with the Injured Organ. Riegues, of Breslau, performed the first successful splenectomy for rupture in 1893. Since that time both tamponade and suture have had their advocates; but splenectomy has come into its own, and is now the standard operation for ruptured spleen. Splenectomy, in contrast to other methods, is rapid and certain.

Technique of Splenectomy for Rupture. The left hand is passed into the wound and the spleen is palpated. Generally a tear can be felt on the convex surface of the organ. The fingers are passed over the convex surface, and thence they seek the pedicle.

A retractor is placed in the left side of the wound, and sufficient blood and blood-clot is wiped away to see the spleen. The organ is now brought gently towards the mouth of the wound. Usually it comes up without difficulty, and can be delivered without any tension into the mid-line incision, especially if there is good retraction in the left side of the wound. If any resistance to delivery is encountered, the fingers of the right hand are at once available to enter the wound, pass over the convex border, and find out the nature of the adhesions which are preventing easy delivery. If adhesions are considerable, the wound must be enlarged by a transverse cut to the left, in order that these adhesions may be separated or divided under vision. As has been emphasized already, this step is hardly ever required in the treatment of ruptured spleen as it is seen in temperate climates.

If necessary, an abdominal pad is packed into the inferior portion of the wound to keep the colon out of the way. The spleen is now under vision. A little systematic swabbing will render the boundaries of the organ clear. By elevating the inferior pole the pedicle is displayed. Clipping, then cutting (*Fig.* 156), little by little and keeping close to the spleen—cutting at the expense of the spleen if necessary— the organ is removed. We now have the pedicle secured by a number
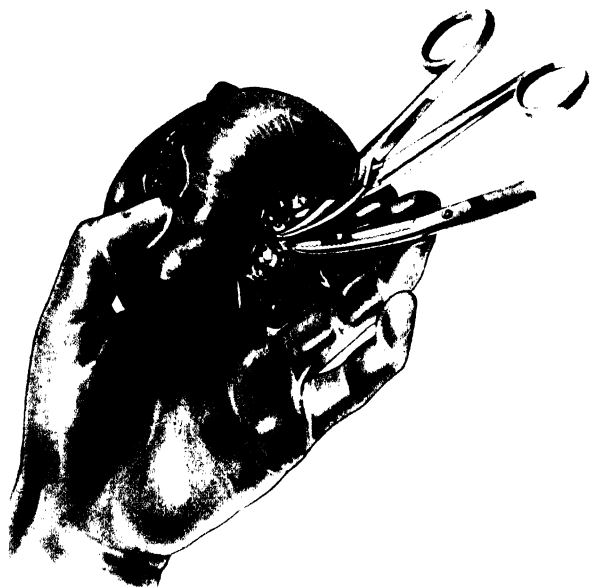
Fig. 156.—Spl little ...icle By clipping, then cutting, little by keeping close to the spleen.

of hæmostats ; losing it is impossible. Each moiety of tissue grasped by the forceps is transfixed with a needle and ligatured. After making certain that the cut surface of the pedicle is dry, it is allowed to fall back.

The technique is simple. It does away with the necessity of mass ligature, where, as it were, all the eggs are placed in one basket. There is no special knot such as a Staffordshire knot to be learnt. There are no catastrophies from cutting out or breaking of the ligatures.

The interdigital grip of the pedicle and the small amount of tissue ligatured at one time considerably reduce the possibility of wounding the tail of the pancreas. There is nothing brilliant about the method— but it is safe.

If the anæsthetist reports ' all well ', a few minutes can be expended in removing blood from the peritoneal cavity. The hands, hollowed in the form of a scoop, are the most efficient apparatus for removing fragmented clot. Palpation of the liver will ensure that a concomitant rupture of that organ is not overlooked. Finally, palpate the tail of the pancreas. If it is damaged, many complications are minimized by a drainage tube brought out on the left flank : if it is intact, no drainage is necessary. The abdomen is then closed.

The Question of Transfusion.— An ideal method is to transfuse the patient with matched blood as soon as the pedicle has been ligated. In practice there are many difficulties in the way. Even if a suitable donor is at hand, the necessary skilled assistance is not always available. Autotransfusion of blood collected from the peritoneal cavity is another method of replenishing the circulation. The blood is collected, mixed with citrate solution, and returned to the patient's veins. Collection of extravasated blood from the peritoneal cavity is somewhat time-consuming, especially when the incision is an upper abdominal one. The procedure is facilitated by a suction apparatus. It must again be taken for granted that there is the necessary skilled assistance at hand if this method is to be used.

In the majority of instances the infusion of saline must of necessity be substituted for the more ideal method of blood transfusion. A good method for the single-handed surgeon is to commence the opera- tion by inserting the needles of a subcutaneous apparatus into the breasts, and allow saline to be absorbed during the operation. At the conclusion of the operation the needles can be left *in situ* if it is deemed necessary, and the infusion is continued when the patient is returned to bed.

After operation, if it has not been possible before, it is well to have the blood grouped, and have at least a tentative arrangement for a suitable donor, should transfusion be required.

Rupture of the Splenic Vein. I have met with two examples of this condition. In each the peritoneal cavity contained dark portal blood. On palpating the spleen and finding it intact one naturally thinks that the portal hæmorrhage is coming from the liver : only to be disillusioned when the latter organ is examined thoroughly. Under these circumstances observe the splenic pedicle. In both the instances referred to this was the source of the hæmorrhage. Ligature of the splenic pedicle proximal to the source of the hæmorrhage and splenectomy was followed by recovery in both my cases.

Complications after Splenectomy for Rupture.—

Peritoneal Effusion.—Peritoneal effusion amounting to ascites was seen in one of my cases. It was noted on the eighth day after operation, and was accompanied by slight pyrexia. The fluid began to lessen in amount about the fourteenth day, but was demonstrable until the end of the fourth week. Its presence can be accounted for by a leakage of the pancreatic ferments into the greater sac from a wounded tail of the pancreas. It is well known that a large collection of fluid accumulates rapidly in the lesser sac after a traumatic lesion of the body of the pancreas.

'*Burst Abdomen.*'—The wound burst open, and had to be re-sutured under a general anæsthetic, in four of the 32 cases which I reviewed. The most feasible explanation is that pancreatic ferments digest the edges of the abdominal wound and the catgut contained therein. The tail of the pancreas may be wounded when splenectomy is being performed, or, as is probably more usual, it is injured together with the spleen at the time of the accident. There is good authority for the latter conjecture, for at the necropsy of one case of ruptured spleen which died without operation the tail of the pancreas was found to be almost severed.

Left Pleural Effusion.—A pleural effusion on the left side was noted in three instances in the same series, and was treated by repeated aspiration.

Persistent Hiccup.—A persistent hiccup, lasting more than five days and preventing sleep, seriously complicated the convalescence of one patient. Hiccup is probably due to irritation of the branches of the left phrenic nerve on the under surface of the diaphragm.

Splenic Asthenia. This occasionally complicates early convalescence. It commences about the tenth day after splenectomy. The patients become progressively emaciated. There is often some pyrexia. Irritability of temper is rather characteristic. The condition tends to improve on the exhibition of arsenic.

LACERATION OF THE MESENTERY

Should a tear in the mesentery be parallel to the gut (*Fig.* 157) the blood-supply to the gut in the immediate vicinity of the tear is endangered. If the tear is more than two inches in length, resection and anastomosis should be carried out. Small tears may be closed, but always wait a few moments after the closure has been effected before returning the coil of intestine. Even a slight change in colour in the intestinal wall in the vicinity of the injury, as compared with the remainder of the intestine, indicates an impaired blood-supply, and the advisability of resection should be reconsidered. Longitudinal tears (*Fig.* 158) can be closed safely.

For closing mesenteric lacerations the following practice is a good one. Bleeding points are caught, care being taken to include as little tissue as possible in the hæmostats. A ligature is then thrown about two hæmostats situated on opposite sides of the laceration. Thus the ligatures not only ensure hæmostasis, but bring together the edges of the mesentery (*Fig.* 159). This technique has the advantage over stitching in that blood-vessels are not pricked.
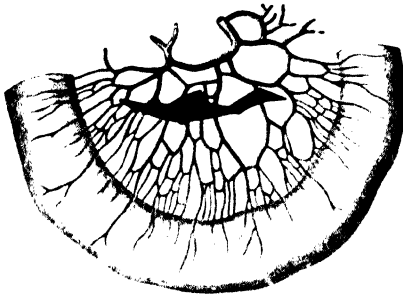
Fig. 157.— Laceration of the mesentery. A tear more than 2 in. in length parallel to the gut. Resection imperative.
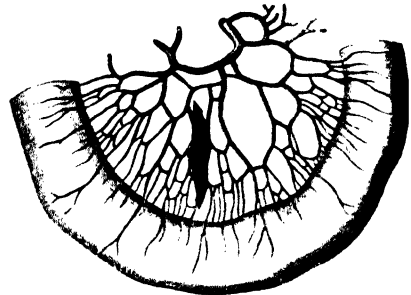
Fig. 158.— Longitudinal laceration of the mesentery. Such a laceration can usually be closed safely.

Hæmatoma of the Mesentery. A large hæmatoma may strangulate the blood-vessels supplying the gut. In deciding whether it is safe to leave a hæmatoma entirely alone, one should first examine both sides of the mesentery. If the hæmatoma is in evidence on both sides, it should not be passed by lightly. When the overlying gut

Fig. 159.— Coapting the edges of the mesentery by ligatures thrown about hæmostats situated on opposite sides of the cut surface.

appears healthy, aspiration of the blood in the hæmatoma may be attempted. If, after aspiration, the hæmatoma re-forms quickly, it is a sign that a vessel requires ligature, and the hæmatoma must be opened. After hæmostasis has been secured, the same precautions of deciding upon the viability of the intestine as were detailed above should be taken.

RUPTURE OF THE LIVER

A precise pre-operative diagnosis is seldom possible—'ruptured liver or spleen' is as near as we can hope to attain. Like certain cases of rupture of the spleen, symptoms of severe intraperitoneal hæmorrhage from a ruptured liver are sometimes delayed for hours, or even days (F. Bertrand). The prognosis of hepatic rupture is always grave. Statistics show a mortality of sixty to sixty-five per cent.
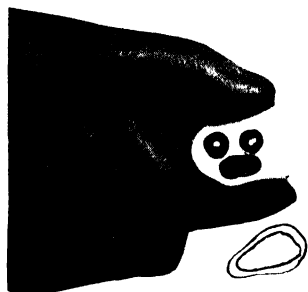
Fig. 160.— Compressing the free edge of the gastro-hepatic omentum in order to control hæmorrhage from the cystic artery. (*Hogarth Pringle's Method.*)

Operation.—

The Incision. — The abdomen should be opened by a mid-line incision. If more room is required this is obtained by making a transverse cut to the right.

By palpation it is discovered that there is a rent in the liver. If the hæmorrhage is excessive, remember to employ Pringle's method of pinching the free edge of the gastro-hepatic omentum (*Fig.* 160).

Method of Displacing the Liver for Exposing its Inferior Surface. —

1. The round ligament of the liver is isolated. The ligament is freed from the abdominal wall by dividing it between ligatures. The end attached to the liver is grasped firmly in the jaws of a long
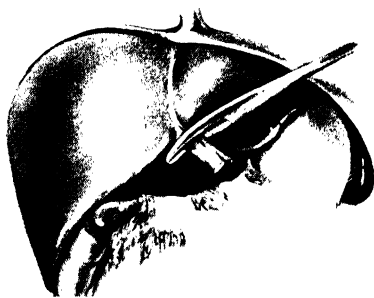
Fig. 161.—Traction on the round ligament enables the operator to elevate the liver somewhat.
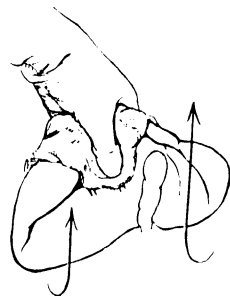
Fig. 162. Method of grasping the liver. (*A. J. Graham.*)

hæmostat (*Fig.* 161). By traction on the round ligament a fair degree of rotation and elevation of the liver can be obtained.

2. Grasping the liver as shown in *Fig.* 162 will be found helpful on occasions.

Wounds on the antero-superior surface of the liver are often made more accessible by inserting abdominal pads between the liver and the diaphragm. This measure displaces the liver downwards fully two inches, and may be the means of bringing a rent into view which otherwise would have to be dealt with blindly.

In stab wounds of the lower thorax Russian and Italian surgeons use the transpleural route very successfully. It is always best to commence with a mid-line incision in order to palpate the rupture. If the liver wound is found to be postero-lateral, proceed by the transpleural incision.

Methods of Dealing with a Wound of the Liver.

Packing. Packing the   with gauze has been employed more often than suture, especially in the past, and it has proved successful in not a few cases. Indeed, this was the method used in the majority of successful cases reported. If the rent is in an inaccessible portion of the liver, packing with gauze is the only possible course to adopt. The first portion of the gauze to be introduced may well be moistened with turpentine. Packing should be left *in situ* for five days, and then removed gradually by the surgeon himself.
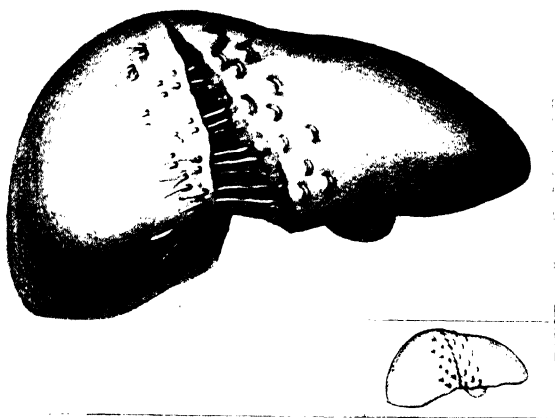
text) : Suturing a deep rent in the liver by tiers of sutures. (*After Rutherford Morison.*)

Suture. Method A. The method of suturing a deep, but accessible, rent in the liver by tiers of mattress sutures (*Fig.* 163) is a good one. In the absence of a special liver needle (*Fig.* 164) (a useful instrument in any surgeon's instrument case), the largest-sized

curved needle threaded with really heavy catgut is the best substitute The needle is passed eye forward, and it is convenient, but not essential, to have it mounted on a holder.

$\frac{1}{3}$ Sc

Fig. 164.   Liver needle.

Rutherford Morison described the following instructive case :—

A miner, aged 17, had been crushed between a brake and tubs. Although the pulse was observed every half hour during several hours, it remained steady at 72. Rigidity and shifting dullness were present. Operation was undertaken seventeen hours after the accident.   " On opening the abdomen blood poured out. This was traced to the liver. Remembering Hogarth Pringle's valuable hint, I passed my left forefinger into the foramen of Winslow, and with my thumb in front, compressed the hepatic artery, portal vein, and bile-duct, arresting all haemorrhage at once. The wound was found to be in the right lobe of the liver, and involving so much of the whole thickness of the organ that the portion on the right seemed to be attached to the left part by only a narrow band.

" The tear was sutured in four tiers with thick catgut. The first line of mattress sutures commenced about $1\frac{1}{2}$ inches from each side of the tear and caught the bottom of it, the next were introduced about 1 inch from the edge, the third about $\frac{1}{2}$ inch, and a final continuous suture brought the fibrous capsule together. Before the sutures were tied any relaxation of the hold upon the gastrohepatic omentum was followed by active haemorrhage, but as soon as the sutures were tied the wound was dry.

" Except for a curious rise in temperature every evening (up to 102 F.) the patient made a good recovery, and went home well fourteen days after operation."
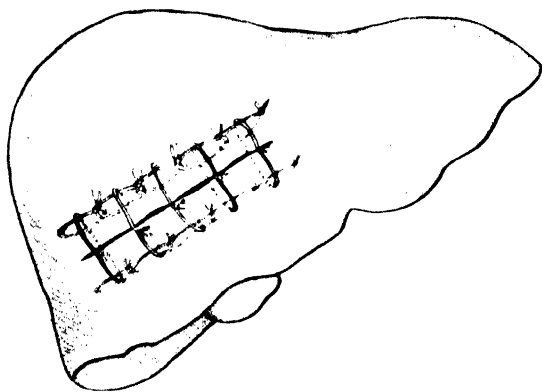
Fig. 165.— Method *B* (*see text*) : Another method of suturing the liver. This is an excellent method for coapting the cut surface of the liver after resecting a tumour, but is inferior to the first method for repairing a traumatic rupture.

Suture. Method B. Deep sutures are introduced parallel with, and about half an inch from, the edges of the rent. These are tied. More sutures are passed at right angles to them, and the latter catch the former, thereby reducing the tendency to cut out. The principle involved can be seen in *Fig.* 165. This is the method *par excellence* of suturing the liver in resecting a tumour. The first layer of sutures is introduced before the resection is performed. As a method of suturing a ruptured liver this method is inferior to the first.

Blood Transfusion. The question of blood transfusion was discussed in the section on RUPTURE OF THE SPLEEN (*see* p. 173). The case of ruptured liver is exactly parallel in this respect.

INJURIES TO THE PANCREAS

It is most improbable that the diagnosis will be made until the abdomen has been opened. There is often a blood-stained exudate, and fat necroses may be present. The approach to the pancreas has been already referred to in the section on ACUTE PANCREATITIS (*see* p. 149).

Rupture of the Pancreas. Suture of the pancreas for complete rupture has been successfully carried out. The pancreas is a friable organ ; to avoid cutting out, the sutures should be passed deeply and tied not too tightly.

Feist's Case.

A man of 19 was crushed between buffers, and experienced excruciating abdominal pain, which shortly passed off, and he walked home. During the night he vomited several times. Later the pain returned, and twenty-four hours after the accident he came under observation. At this time the temperature was normal and the pulse 70. The abdomen was rigid, and shifting dullness could be readily detected. On opening the abdomen a large amount of blood-stained fluid escaped. A retroperitoneal hæmatoma the size of a fist was observed. After incising the peritoneum and sponging away the blood and blood-clot, the pancreas was found to be completely ruptured about its middle. The edges were trimmed up, bleeding points ligatured, and the two halves of the pancreas united by sutures. The peritoneum was drawn over the site of the rupture and the lesser sac drained. On the twenty-first day three small necrotic portions of pancreas were extruded from the sinus where the drainage tube had been placed, after which convalescence was uneventful.

In other instances the pancreas has been found to be lacerated but not completely divided. Drainage of the lesser sac is all that is necessary in these cases. A number of successful cases treated on these lines have been recorded.

Injury to the Pancreas Complicating Ruptured Spleen. In this instance the tail of the pancreas may be completely severed from the body. The fragments should be removed and drainage provided through a stab incision in the left flank.

The after-treatment of pancreatic injuries requires the same watchful attention of the abdominal wound as in the case of acute pancreatitis (see p. 151), for escaping pancreatic ferments tend to digest the edges of the wound and the catgut sutures in the abdominal wall.

Pseudo-pancreatic Cyst following an Injury to the Pancreas. The development of a large collection of fluid in the lesser sac (pseudo-pancreatic cyst) following a pancreatic injury is a recognized clinical entity. The interval elapsing between the injury and the recognition of the cyst is usually between one and three weeks.

W. K., aged 20, was admitted with abdominal pain and repeated vomiting. Fourteen days previously he had been jammed between a pillar and the shaft of a horse van. After the accident he walked home and called in a doctor. Since that time he had been in bed, and had had a dull pain in the upper abdomen, but vomiting was the chief complaint. He had vomited twelve times on the day of admission and eight times on the previous day. On examination the patient looked pale and ill. The pulse was 100 and the temperature 99°. There was a large tender swelling, dull to percussion, extending from beneath the left costal margin to the umbilicus. On opening the abdomen the stomach was found to be pushed forward by a tense cystic swelling in the lesser sac. There was a considerable amount of straw-coloured fluid in the general peritoneal cavity. After packing off the area so as to avoid soiling the general peritoneal cavity, the lesser sac was opened *between the colon and the greater curvature of the stomach (Fig. 166).* Pints of yellowish opalescent fluid escaped, and as the cyst collapsed some flocculent curd-like material was evacuated. The walls of the lesser sac were thickened and covered with altered blood-clot, especially over the pancreas. A tube was passed into the lesser sac and the wound closed about the tube. Except for an attack of vomiting on the twenty-second day after operation convalescence was uneventful. The sinus took over six weeks to close finally. An examination of the fluid evacuated showed it to be sterile, but rich in pancreatic ferments.
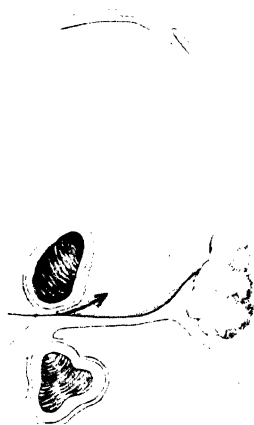
Fig. 166. — Pseudo-pancreatic cyst following injury of the pancreas. The lesser sac is drained by opening the peritoneum between greater curvature of the stomach and the transverse colon.

INJURY TO THE GALL-BLADDER AND BILE-DUCTS

On opening the abdomen, if *bile* is chiefly in evidence, examine: (1) The gall-bladder; (2) The duodenum; (3) The cystic duct; (4) The common bile-duct; (5) The hepatic ducts.

Moynihan's method of rotating the common bile-duct may be useful in searching for the point of rupture. The left hand is passed in transversely above the stomach along the gastrohepatic omentum. When the hand is well placed, the fingers are flexed and the hand and wrist are bent over to the patient's left, with the result that the common duct is twisted up into the wound.

RUPTURE OF THE GALL-BLADDER

If the gall-bladder is found to be irreparably damaged, cholecystectomy will have to be performed, but there can be but few cases in which the remnants of the gall-bladder cannot be patched around a tube. In most cases the tear is a small one. If it is near the fundus, the hole can be used for cholecystostomy; if elsewhere, it should be sewn up and deliberate cholecystostomy performed. The peritoneal cavity should be drained.

Run-over accidents have accounted for most of the cases. The late W. Thelwall Thomas, of Liverpool, operated upon a boy who had been run over by a cart. On opening the abdomen bile poured forth. The torn gall-bladder was stitched about a tube, and in addition the peritoneum was drained. The boy recovered, and five years later I saw him when he presented himself on account of some vague abdominal pain.

A rupture of the gall-bladder in a healthy subject results in extravasation of normal bile, which is sterile. If operation is undertaken reasonably early, the results are exceedingly good. Rickets collected 28 cases of this accident submitted to operation, of which 22 recovered.

A *localized* collection of normal bile may be present in the peritoneal cavity for a very long time without giving rise to serious symptoms. The following case was reported by Fifield : —

A youth, aged 22, was run over by a cart. He was treated expectantly and apparently completely recovered from the accident. Two months later he visited his doctor, complaining of a gradual increase in the size of his abdomen. He was not jaundiced. Laparotomy was performed by Mr. Hutchinson, and an enormous collection of bile was found in the subhepatic pouch, the right anterior subphrenic space, and the right lumbar fossa. In the remaining part of the peritoneal cavity (which was shut off by adhesions) was a large quantity of serous fluid. The hole in the gall-bladder was sutured and the subhepatic fossa and pouch of Douglas drained. Recovery.

TRAUMATIC RUPTURE OF THE BILE-DUCTS

Rupture of some portion of the bile-passages is not, as a rule, rapidly fatal. Often it is the gradual distension of the abdomen with fluid, and perhaps jaundice, which call attention to the condition after several days.

When the patient has been left until he is in a poor condition, drainage is all that can be done. If the rupture is incomplete, recovery

may ensue.   Simple drainage is unlikely to cure a complete lesion, but
may tide the patient over until he is fit for a reconstructive operation
If he is in good condition and the lesion complete, or nearly so, an
attempt to restore the continuity of the bile-passages should be made.

Complete Rupture of the Hepatic Duct.—If the ends are accessible,
the delicate operation of end-to-end anastomosis should be attempted
if possible.   It is necessary to have the patient in the 'gall-bladder
position', and a good light is helpful.   The posterior aspect is united
with interrupted sutures passed on a fine curved needle.   A piece of
rubber tube is then placed in the ends of the duct and more sutures
are passed, but not tied.   When the latter have been inserted, the
tube is removed and the sutures tied.   (*Fig.* 167.)
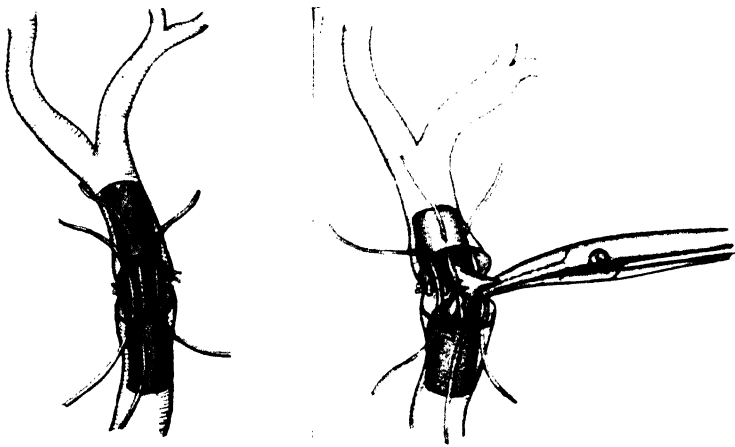
Fig. 167.—Repair of a complete rupture of the hepatic or common bile duct
a, A piece of rubber tube is placed in the ends of the duct to aid the passage of
interrupted sutures ;   *b*, After the sutures are placed, but before they are tied,
the tube is removed.

The alternative is to rely on simple drainage alone, and if, as will
probably be the case, a permanent biliary fistula results, reconstruction
of the duct by Walton's method may be undertaken at a later date.

Garré's Case.—
Operation was undertaken soon after the accident.   The lesion was
found to be a complete rupture of the hepatic duct.   This was united by
sutures.   The patient recovered, but further operative treatment was
necessary one year later for cicatricial contracture at the site of the
anastomosis.

Complete Rupture of the Common Duct.   We have two possible
courses :   (1) Direct suture by the technique described above ; or

(2) Ligature of both ends of the duct and cholecystgastrostomy (*Fig.* 168). The latter appears to be a very good proposition.

O. F. Paget's Case. –

A boy, aged 7 years, was run over on March 14. When seen on April 4 he was jaundiced and emaciated, the abdomen was full of fluid, and there was no bile in the stools. Aspiration was performed, and 3 quarts of aseptic bile were removed from the abdomen. On April 8 the abdomen was opened. Bile was found leaking from the common bile-duct. As the patient's condition was critical a tube was passed down to the region of the tear, and the abdomen closed. From 10 to 12 oz. of bile were passed through the drainage tube in twenty-four hours, while none appeared in the stools. Thus a difficult problem had to be faced. A very emaciated child, with a pulse of 130, required a delicate operation. On April 26 Paget performed the second operation.

Fig. 168. Complete rupture of the common bile-duct. Both ends of the divided duct are ligatured and cholecystgastrostomy is performed.

The gall-bladder was sutured to the colon and the abdomen was closed, a drainage tube being inserted. The patient was removed from the table barely alive. In the days which followed bile continued to drain externally. On May 7 there were severe pains in the upper abdomen, apparently due to peritonitis, and on May 8 the motions were coloured brown. A week later no bile appeared in the wound and the colour of the motions was normal. The temperature varied from 101 to normal. Recovery ensued.

Rupture of the Cystic Duct. Clearly the treatment indicated is to clamp and ligature the stump and to perform cholecystectomy. (*Fig.* 169.)
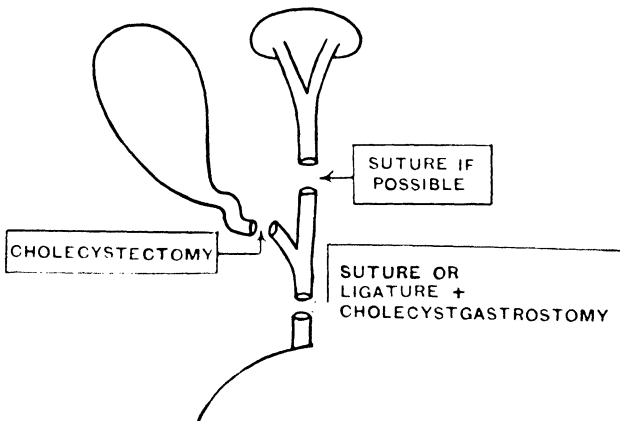
ethods of treating early plete tears of the biliary tract.

RUPTURE OF THE INTESTINE

The diagnosis is suggested by the history. Local tenderness is often the key to the site of the rupture. If localizing signs are present (*Fig.* 170), open the abdomen by the right paramedian or the upper mid-line incision, as the case may be. If localizing signs are absent, use the upper mid-line incision, for reasons given already. On opening the abdomen, purulent, fæcal, or bile-stained fluid may be found, and suggests the segment of the intestine to be examined first. It should be noted, however, that in early cases there is often only a little blood-stained fluid in the peritoneal cavity.

We will assume that the site of the rupture is not evident. Examine the duodenum and the duodenojejunal flexure. If this is negative, commence a survey of the whole of the small intestine, a rather laborious undertaking. The first loop of jejunum is withdrawn, and the whole of the twenty-three feet of small intestine is run through the fingers. The assistant should be detailed to replace the intestine, coil by coil, into the abdomen. A hot towel should be placed about the upper end of the wound so that any exuberant coils may be kept covered. Replacement cannot be expected to keep pace with delivery and examination.

Fig. 170. Monk's method of intestinal localization. **A B.** line of mesenteric root. Parallel lines are erected at the extremity of this line, dividing the abdomen into three equal parts. The upper, middle, and lower compartments here indicated contain, in most cases, the upper, middle, and lower thirds of the small intestine respectively.

A rupture should be closed with a double layer of catgut. Catgut on an eyeless needle is the most suitable material, but the catgut should have been soaked in warm saline. When it first comes out of the glass container it is very wiry and difficult to work with.

Small punctures are closed by a purse-string suture. Before attempting to close a large laceration, in order that the gut may be steadied and slightly stretched, it is convenient to pick up the intestine in Lane's tissue forceps just beyond the extremities of the tear whilst the sutures are being inserted. Leakage of intestinal contents is arrested by placing an intestinal clamp on the proximal side of the

rupture. This, however, is seldom called for, for the pouting mucous membrane prevents much outpouring. Always remember to sew up large perforations in the transverse axis of the gut to prevent undue narrowing of the lumen (*Fig.* 171). However, if it is found, after sewing up an extensive tear, that some narrowing of the gut has occurred, this need not be a source of anxiety, for the contents of the small gut are fluid and their passage is unaffected by a certain amount of constriction.

After closing the perforation the suture line can be reinforced with an omental patch.

Fig. 171. Repair of a large wou up transversely to prevent narrowing a purse-string is used.

The gut should be sewn small puncture wounds

Unless the mesentery, with its all-important blood-supply, is involved in the laceration, there is seldom any need for resection.

Ten per cent of intestinal ruptures are multiple ; therefore do not be satisfied by finding and closing one rent, but examine the whole course of the gut.

A suprapubic drainage tube should hardly ever be omitted.

Case 1. Male, aged 41. Stated that twenty-seven hours previously, whilst groping about to find a match, he fell over a chair and caught his abdomen to the left of the navel on a fender. Immediately afterwards

he was in great pain and crawled to bed, but had no sleep. Agonizing supra-umbilical pain continued all night, *but there was no vomiting.* He had passed urine twice since the accident.

On examination, pulse 84, temperature 98 . The abdomen moved well on respiration. The skin was burnt with a poultice above the umbilicus. There was *intense general rigidity.* Shifting dullness could be elicited. The most tender spot was just to the left of the umbilicus. Per rectum there was tenderness in the rectovesical pouch. A diagnosis of ruptured intestine was made. Mid-line laparotomy. Free fluid in the general peritoneal cavity and much flocculent general peritonitis. The duodenum and duodeno-jejunal flexure were examined and found intact. The small intestine was then passed through the fingers. Three feet from the duodenojejunal flexure there was a tear two inches long near the mesenteric border. This was sewn up with a double layer of catgut, and the suture line reinforced with omentum. The rest of the intestine was examined with a negative result. Suprapubic drainage.

During convalescence the real cause of the accident came to light. He had been kicked in the stomach by his wife. One year later he was seen in perfect health.

Case 2.—Male, aged 40. Saw a policeman endeavouring to arrest a drunken student, and went to the aid of the law, with the result that he was kicked in the hypogastrium. Four hours later he was admitted to hospital.

On examination he was very considerably shocked. The temperature was 96 , pulse 84. There was boardlike rigidity and tenderness, most marked to the right of the umbilicus. The abdomen was opened by a two-inch mid-line incision above the umbilicus. Nothing abnormal was discovered. The incision was therefore closed, and a right lower paramedian substituted. On opening the peritoneum, faecal fluid escaped. A perforation was found one foot from the ileocaecal valve. The tear was one inch in length, and was situated on the antimesenteric border. The perforation was closed. Suprapubic drainage.

For the next few days the patient was in a desperate condition, the abdomen distended and drum-like. Improvement set in on the seventh day, and, with the exception of some suppuration in the lower abdominal wound, he made a good recovery.

Case 3.—Male, aged 39. Fell fifteen feet from a scaffold. An iron barrow which he was wheeling fell on top of him.

On admission he was profoundly collapsed and blanched. Pulse 110 ; the temperature would not register. On examining the abdomen there was general board-like rigidity. The maximal tenderness was in the left hypochondrium. A catheter was passed, and the urine found to be normal. A diagnosis of ruptured spleen was made. By the time he reached the theatre half an hour later, pallor was profound and the pulse barely perceptible.

Mid-line upper laparotomy. The peritoneal cavity was full of blood. The spleen and liver were intact. The haemorrhage was found to be coming from a tear in the mesentery through which the fist could be passed. The intestine itself in the immediate neighbourhood contained no less than seven perforations in five feet (*Fig.* 172). This segment of jejunum containing the ruptures was resected, for the hole in the mesentery had, to a large extent, cut off its blood-supply. End-to-end anastomosis was

performed. At this stage the patient stopped breathing, and death appeared imminent. The abdomen was closed by through-and-through sutures as quickly as possible, and as this was being done occasional sighing respirations occurred. The head of the table was tilted downwards, and an intravenous gum arabic infusion given.

He was returned to bed, and six hours later had fully regained consciousness and gave some hope of recovery. His pulse was 132 and his temperature 97. During the night his condition became grave, and he died. The post-mortem showed a tear one inch in length in the mesentery four inches from the ileocæcal valve. The renewed hæmorrhage which had occurred from this lesion probably determined the fatal issue.
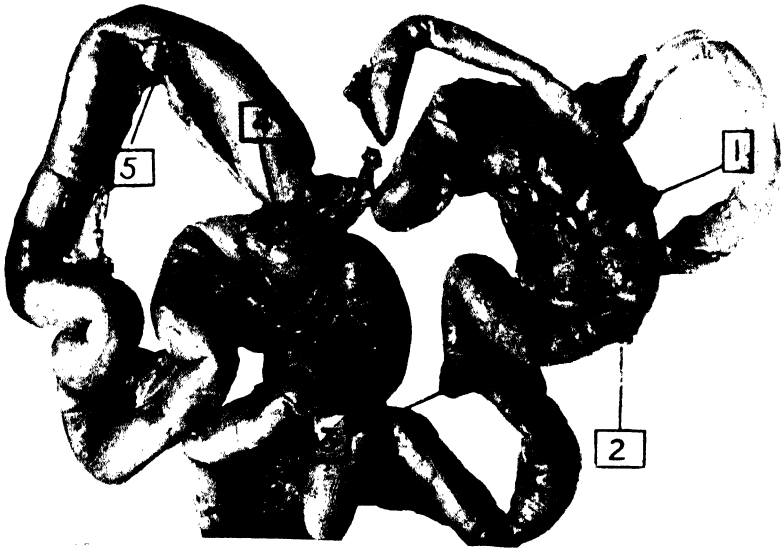
n 5 ft. in length containing seven perforations
on had to be undertaken because of a large
e multiple wounds should be sutured.

Rupture of the Duodenum. Particularly if the tear is situated in the second part of the duodenum, the mid-line incision gives inadequate exposure. Additional room is afforded by making a transverse cut to the right, as was successfully employed in the case cited below.

Another method which might be used is to make a special, rather large, gridiron incision over the second part of the duodenum, using a hand inside the abdomen as a guide. This method gives good access to that portion of the duodenum which is least accessible from the mid-line. The central incision should not be closed until we are certain that there is no further use for it — i.e., until the rupture of

the duodenum has been dealt with satisfactorily. An added advantage of this method of approach is that, if the wound suppurates, two comparatively small incisions do not give rise to the same anxiety as one large incision which in part has divided the rectus.

A rupture of the duodenum may be: (1) Extra-peritoneal; (2) Intra-peritoneal; (3) Both extra- and intra-peritoneal.

Extra-peritoneal Rupture.— A complete extra-peritoneal lesion may produce few symptoms until extravasation of duodenal contents accumulates. Even when the peritoneum has been opened, a retroperitoneal rupture sometimes escapes notice. A retroperitoneal duodenal rupture was overlooked in spite of laparotomy in 11 cases cited in the literature (Söderlund). The most characteristic finding is a bulging of the parietal peritoneum in the region of the duodenum. Drainage of this collection is liable to be followed by a duodenal fistula. A profuse duodenal leakage brings about rapid and extreme emaciation of the patient. In addition, the skin around the fistula soon becomes terribly excoriated, a combination of affairs which, unless remedied, often carries off the patient.

The following is a case of rupture of the duodenum, mainly extra-peritoneal, followed by duodenal fistula.—

On October 27, 1924, a youth of 18, whilst playing football, fell forward on to the boot-heel of another player, striking his right side. He was helped off the field, and soon afterwards vomited. On examination there was a bruise over the right rectus with rigidity in this region. The pulse and temperature were normal. Spasmodic pain and vomiting continued. Next morning the pulse was 100 and the temperature 101 .

Operation (Mr. Robert Going): Mid-line laparotomy. There was no free fluid on opening the abdomen. A tear was seen in the peritoneum over the second part of the duodenum. The incision was enlarged by a transverse cut to the right. A small tear was found in the second part of the duodenum. This was sutured and reinforced by omentum. The right kidney pouch was drained. After some bile-stained fluid had been mopped up from the right iliac fossa the abdomen was closed.

Improvement continued until one week later, when quantities of bile-stained fluid commenced to flow from the stab wound. As a result, the patient became rapidly emaciated and the skin around the wound excoriated and acutely painful. The patient was transferred to the London Hospital on Nov. 6. I was fortunate in being able to examine him with my chief, Sir Hugh Rigby. Hollow-eyed and emaciated, he looked the picture of extreme dehydration. The pulse was 100 and the temperature 97 . Rectal saline with glucose was ordered, with considerable benefit. The following day Sir Hugh Rigby performed gastro-enterostomy and occluded the pylorus with silk. Before closing the abdomen, after placing a purse-string in position, a catheter was inserted into the jejunum and a feed of peptonized milk with eggs beaten up was given into the jejunum. There was a lessening in the discharge after the third day, and a week later the patient began to gain in strength. The hollow-eyed, emaciated face began to fill out as the discharge lessened. Gradually the wound healed, and the patient recovered completely.

(*See also* DUODENAL FISTULA FOLLOWING PERIGASTRIC ABSCESS, p. 112.)

Intra-peritoneal Rupture.—A small rupture is closed in exactly the same way as a perforation of a duodenal ulcer. If the rupture is situated in an inaccessible part of the duodenum, the special incision described above may be used with advantage. If the condition of the patient is good and doubt exists as to whether the suture line is watertight, gastro-enterostomy with pyloric occlusion may be advisable, to prevent the formation of a fistula. Nevertheless, it should be borne in mind that this step can be undertaken, if it is required, at a later date. The right kidney pouch should be drained invariably.

Complete Rupture.—The condition of the patient is usually grave and the treatment difficult. Continuous saline infusion should be employed throughout the operation. Both ends of the duodenum should be closed (*Fig.* 173), silk being employed for the second for catgut is liable to be digested by the pancreatic ferments. When closure has been effected, posterior gastro-enterostomy is performed, and the right kidney pouch drained.

When this method is used it is said that, if the rupture is below the biliary papilla, regurgitant vomiting is a troublesome sequel. Moynihan's case cited below does not support this.
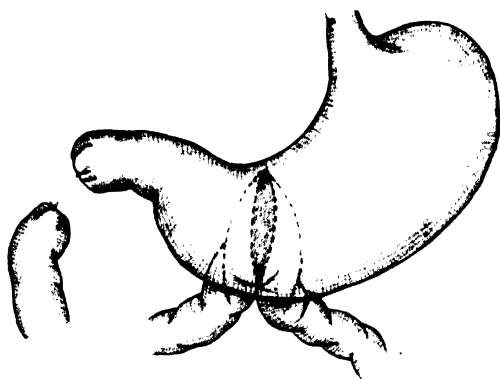
Fig. 173. Complete rupture of the duodenum, closure of the severed ends and posterior gastro-enterostomy.

Complete Rupture of the Duodenojejunal Flexure. In 1901, Lord Moynihan reported the following case, which illustrates many important points :—

E. H. L., a boy of 6, was admitted to Leeds General Infirmary having sustained an abdominal injury. On opening the abdomen there was an escape of blood. A rapid search soon revealed that there was a complete tear of the duodenojejunal flexure. The jejunum appeared to have been torn out from the duodenum in such a manner that the divided end of the duodenum was beneath the peritoneal level. The jejunum in its upper $4\frac{1}{2}$ inches was torn away from its mesentery ; this portion was removed. The duodenum was closed by a continuous suture, and over this the peritoneum was approximated. The suture line was reinforced by the flap of torn

mesentery already referred to. The jejunum was now implanted into the anterior wall of the stomach (*Fig.* 174, *a*), Murphy's button being used for the anastomosis.

The child progressed until the 104th day after operation, when perforation of the duodenum by the Murphy's button occurred, causing death in a few hours.

To-day, suture has entirely supplanted the use of Murphy's button, and it is reasonable to assume that this unhappy ending would have been averted had sutures been used. Nevertheless, it must be admitted that there is always a danger of solid objects finding their way into the duodenal cul-de-sac after this type of operation. Steudel performed a similar operation on dogs. The dogs thrived for a time, but eventually died of perforation of the duodenum by fragments of bone which they had eaten and which had passed from the stomach through the pylorus.

Fig. 174. Treatment of complete rupture of the duodenojejunal flexure. *a*, Moynihan's operation. The duodenal end of the severed intestine is closed and buried. The jejunal end is implanted into the stomach. *b*, A more ideal, but considerably more difficult, operation is to implant the jejunum into the third part of the duodenum.

The ideal method of restoring the continuity of the alimentary tract after this accident would be to implant the jejunum into the third part of the duodenum (*Fig.* 174, *b*) a much more difficult operation, and on that account only to be attempted by the experienced when the patient's condition is good.

Moynihan's case illustrates another important point. Regurgitation of bile and pancreatic juice into the stomach does not interfere in any degree with the function of the viscus.

Traumatic Rupture of the Large Intestine. Of 221 cases of rupture of the intestine without external wound, collected by Sir James Berry, only 15 were of the large intestine. Rarely is the large intestine torn across completely ; by reason of its size wounds are mostly of the nature of a tear or perforation, and can be dealt with by suture. When possible, the suture line should be reinforced by omentum. Peritoneal drainage must be carried out invariably.

Retroperitoneal Rupture of the Large Gut. Local emphysema, commencing in the flank and spreading around the abdominal wall, occurs comparatively early if the rupture is not recognized. This is

due to the escape of gas-forming organisms. Retroperitoneal injuries, by reason of this infection of the subperitoneal tissues, are even more fatal than intraperitoneal wounds. It behoves the surgeon to satisfy himself as to the presence or absence of a retroperitoneal wound in addition to the more obvious and accessible peritoneal injury.

As a means of preventing fatal infection of the retroperitoneal space, colostomy may prove a life-saving measure; but it must be employed at a very early stage, before the infection has obtained a hold of the cellular planes behind the peritoneum, and it must not be used as an alternative to the establishment of free and adequate local drainage (Gordon-Taylor).

Compressed-air Rupture of the Large Intestine.—This is nearly always the result of a damnable form of practical joke. A hose, carrying air under considerable pressure, is turned on near the victim's anus.

The point of rupture is usually in the omega loop. Suture of the perforation and drainage of the peritoneum within an hour or two of the accident is the only hope. Block and Wisemann collected 27 cases of compressed-air rupture of the large gut, and found the mortality to be 70·3 per cent. Their own case recovered. A case reported later by Hays also recovered, but in each of these instances operation was carried out within two hours of the accident.

TRAUMATIC RUPTURE OF A MESENTERIC CYST

S. S., aged 5½, was pushed over in a playground at school, and immediately cried out with pains in the stomach. Four hours later, when admitted into hospital, the child was obviously shocked. On examining the abdomen rigidity was found and the percussion note was dull. During the two hours he was under observation the pulse rose from 106 to 130. A diagnosis of ruptured spleen was made.

On opening the abdomen, fluid like curdled milk ran out in large quantities. This was traced to an opening near the duodenojejunal flexure. I was about to suture up the ragged hole, believing that the duodenojejunal flexure had been torn, but the absence of bile in the fluid caused me to make a more thorough examination. It was soon clear that a mesenteric cyst had ruptured. The third and fourth parts of the duodenum and the neighbouring jejunum had been pushed upwards by the cyst wall. A tube was passed through the hole in the cyst and the cyst wall closed about the tube. The general peritoneal cavity was drained. The abdomen became very distended on the second day, but the bowels moved freely. After the fourth day recovery was uneventful.

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CHAPTER XIV

INTESTINAL OBSTRUCTION:
INTRODUCTION. OBSTRUCTION OF THE LARGE GUT

The Toxæmia of Intestinal Obstruction and Methods of Combating it.

In intestinal obstruction certain lethal products are absorbed from the small intestine ; what exactly these are is a debatable point. Some maintain that they are bacterial toxins, whilst others (notably McQuarrie and Whipple) have isolated proteoses from the obstructed contents of the bowel which, when injected into dogs, produce signs of toxæmia comparable with those of intestinal obstruction. There can be little wonder that, so long as the etiology is a matter for speculation, views as to the best method of combating the toxæmia are divergent.

Methods of Combating the Toxæmia.

1. Saline infusions are of undoubted value.

2. Aspiration of the stomach contents ; in some instances continuous gastric aspiration often has temporary beneficial effect in cases of advanced intestinal obstruction.

3. In obstruction of the small intestine, evacuating the contents above the point of obstruction at the time of the operation appears to be the best *mechanical* means of ridding the patient of potentially absorbable toxic bodies (*see* p. 222).

4. Anti-gas-gangrene (*B. welchii*) serum. Williams, working at St. Thomas's Hospital, demonstrated that anti-gas-gangrene serum was a definite adjuvant to the surgical treatment of intestinal obstruction and the paralytic ileus which accompanies general peritonitis. The serum used was Burroughs Wellcome & Co.'s Series, G155. Later a more concentrated serum was manufactured, G194 (*Fig.* 175), and it is this that is used at the present time : 10 c.c. are given intramuscularly daily, until the bowels act freely.

Prophylactic Dose. When the obstruction is not of very recent origin and the patient is very toxic—a class of case which it is our misfortune to meet only too often—the wisdom of still further delaying operation for an hour whilst saline is administered seems established. To supplement our pre-operative measures a prophylactic dose of 7 c.c. of G194 is given intravenously.

4. St. Leger Brockman believes that the toxæmia of intestinal obstruction is mitigated by the rectal injection of human bile, of

which he gives 2 oz. admixed with 4 oz. of saline. Human bile is not easily procurable in times of emergency. A patient with a cholecystotomy may be able to supply the substance. If the patient who is suffering from acute intestinal obstruction has vomited bile, the vomitus, after straining through gauze, can be returned per rectum.

Jejunostomy and ileostomy are discussed on p. 224 et seq.
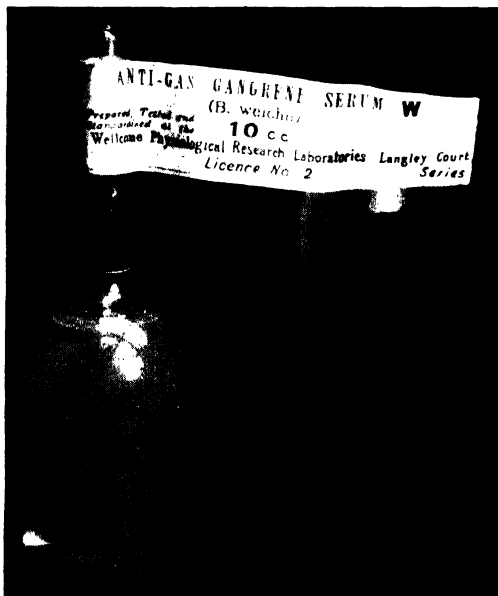
Fig. 175.—Capsule of concentrated anti-gas-gangrene serum, G194.
(Burroughs Wellcome & Co.)

Laparotomy for Intestinal Obstruction of Uncertain Origin (*Fig.* 176).—*Anæsthesia.* The value of spinal anæsthesia in intestinal obstruction has been noted on p. 17. Other things being equal, the right lower paramedian incision is used, the rectus muscle being mobilized and retracted outwards. A point above the linea semilunaris is chosen for opening the peritoneum, which should be done with great care, for a distended loop may be just beneath. A hot, moist towel is in readiness to cover up any intestine which escapes. The first step is to inspect the cæcum. It is not sufficient to palpate it ; it must be seen.

If the cæcum is ballooned and tense, it is certain the obstruction is in the large gut. Palpate the upper rectum and sigmoid. If

the cause of the obstruction is not there, trace round the colon, paying especial attention to the splenic and hepatic flexures.
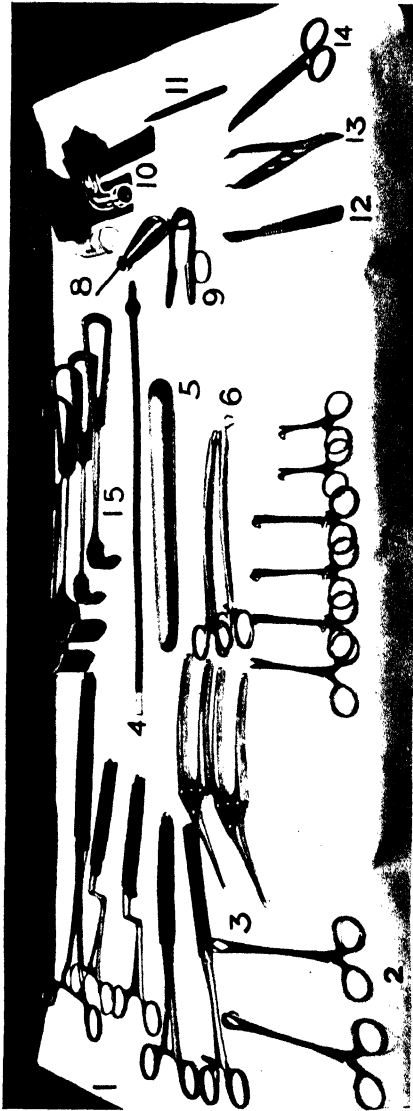
If the cæcum is not distended, the obstruction lies in the small gut. Try and locate a loop of *collapsed* intestine, and follow this to the

point of obstruction (*Fig.* 177). If a collapsed loop of intestine cannot
be found readily, explore the pelvis and the right iliac fossa. If the
obstruction lies in the small intestine, the gut in the region of the
ileocæcal valve *must* be below the obstruction.

It has long been taught that we should studiously avoid allowing
the intestines to escape on to the surface, and that anything in the
nature of evisceration is the essence of bad surgery. Holden, in an
instructive paper based on 135 personal cases of intestinal obstruction,
challenges this view. He finds that there is practically no shock in
evisceration if the intestines are covered up with hot, saline-soaked
towels. If the obstructing agent is difficult to locate, partial or sub-
total evisceration should be performed, having hot saline-soaked

Fig. 177.—Intestinal obstruction of uncertain origin. Tracing a loop
collapsed intestine to the site of the trouble. (Towels omitted for the sake
clearness.)

towels in readiness to cover up the intestine. The assistant
be requested to see that all the prolapsed intestine is covered
that the towels are changed as soon as they become cool.

Classification. Acute, and acute on chronic, intestinal obstruction
is a large and difficult subject upon which to write. After due con-
sideration I have decided to divide it into two great classes: (1)
Obstruction to the large gut (with which the remainder of this chapter
deals); (2) Obstruction to the small gut; and to leave the consider-
ation of external herniæ (which are in a class by themselves) to a later
chapter. In a few instances this classification leaves something to be
desired, for conditions such as intussusception are common to both
the large and small gut; in such instances the subject matter is
arranged in the manner which it is thought will be most convenient
for study and for reference.

OBSTRUCTION OF THE LARGE GUT

GENERAL EMERGENCY MEASURES

Cæcostomy. Should *blind* cæcostomy be performed when the diagnosis of acute obstruction due to a carcinoma of the colon is practically certain ? The answer is " Yes, if the case is one of very grave emergency." As a general rule, it is wiser to explore the abdomen through a right paramedian incision. If spinal anæsthesia is used this does not add greatly to the length or shock of the operation. To perform cæcostomy without exploring the abdomen is to run the risk of overlooking some possibly remediable condition. Furthermore, cæcostomy is not the operation of choice if the growth is found to be inoperable. Cæcostomy is the ideal *temporary* drainage of the large gut ; the contents of the cæcum are liquid and escape readily. But as a permanent drainage it is objectionable : the fæces are quite uncontrollable, and the skin soon becomes excoriated even with the greatest care.

To sum up : In acute large-gut obstruction cæcostomy is the best temporary drainage when subsequent resection of the growth is contemplated. Blind cæcostomy, owing to its simplicity and efficient drainage, often proves a life-saving measure in desperate cases ; but I consider that blind transverse colostomy in such cases is equally good. The latter has the advantage that, should the growth be inoperable, the patient is left with a permanent (transverse) colostomy. A transverse colostomy is an artificial anus second to none for comfort and control. Permanent cæcostomy means an existence which few can tolerate.

Technique of Cæcostomy. If laparotomy has been performed, the wound should be closed and the incision protected by an anchor dressing before commencing the cæcostomy (*Fig.* 178).

Fig. 178. Lapar- otomy has been per- formed and it has been decided to perform cæcosto laparotor cl sed with an

The incision is the same as that used for grid- iron appendicectomy. It should be a small not more than 2 in. in length – the smaller it is, the less there is to break down, for infection of the wound is almost inevitable.

The peritoneum is opened with due care. The cæcum is with- drawn very delicately, for it may be in imminent danger of bursting. A rubber tube about eight inches long and a quarter of an inch in diameter is used to drain the cæcum in the following manner (Lockhart-Mummery's technique). The exposed portion of cæcum

is drawn through a hole cut in the centre of an abdominal pad. A
purse-string suture is placed in the cæcal wall so that it turns in about
half an inch of cæcal wall around the tube when it is tied. A rubber
clamp is applied to the cæcum and a small stab incision is made in the
appropriate part of the cæcal wall. The edges are grasped in
hæmostats, and by this means the cæcum can be held up while the
intestinal clamp is loosened. Gas escapes, but if the cæcum is held
up well, usually the escape of fæcal matter can be prevented while
the tube is inserted swiftly. The tube is passed into the cæcum for
two or three inches and fastened to the cæcal wall by a catgut stitch.
The purse-string suture is tied. Sometimes a second purse-string
suture is advisable. The ends of the purse-string are passed through
the peritoneum, and this fixes the cæcum in the bottom of the wound.
The incision in the abdominal wall is closed, but not tightly, so as to
leave some drainage beside the tube.

Difficulties and Dangers of Cæcostomy. —

1. On opening the peritoneum it is not a very rare occurrence
for the *cæcum to perforate spontaneously.* Usually the perforation is
small and the hissing of escaping gas is heard. See that the assistant
is plentifully supplied with swabs to mop up any fæcal matter which
escapes. Deliver the portion of the cæcum which has perforated,
extending the incision upwards if necessary. Apply a clamp and
sew up the perforation, liberally invaginating the cæcal wall in the
immediate neighbourhood. Having closed the perforation, perform
cæcostomy in the usual manner, but avoid utilizing the sutured
portion as the spur. It is not good practice to economize by utilizing
the perforation for the designed orifice : so often it ends in the purse-
string cutting out and a gross contamination of the peritoneum.

2. *The whole cæcum is green and surmounted with gangrenous
patches.* In one such case the cæcum and the terminal portion of the
ileum were brought on to the surface and stitched to the wound in a
few places. A large portion of the cæcum sloughed. By the seventh
day the appearance was that of a normal cæcostomy, and the result
proved very satisfactory.

3. *The cæcum is bound down and cannot be delivered.* I have had
the misfortune to encounter such a case, and manipulations designed
to deliver the cæcum caused a large perforation. If the cæcum is
bound down do not attempt cæcostomy. Close the wound and per-
form transverse colostomy. With the cæcum and ascending colon
fixed to the posterior abdominal wall, right lumbar colostomy should
be a sound operation. *Fig.* 179 is a photograph of a case where the
cæcum could not be delivered and transverse colostomy was performed
instead. She did well. Subsequently the growth in the pelvic colon
was resected and end-to-end anastomosis performed.

Post-operative Management of the Cæcostomy.   A long piece of soft rubber Paul's tubing is attached to the projecting end of the rubber drainage tube by whipping a thread around for a couple of inches.   The end of the Paul's tubing is allowed to drain into a bucket.   If the cæcostomy is not draining copiously the nurse is instructed to run a pint of water into the cæcum every two hours. This is easily done by putting a glass funnel into the free end of the Paul's tubing.   After twenty-four hours half to one ounce of magnesium sulphate dissolved in one pint of water is run into the cæcum.   The

Fig. 179.   Acute on chronic intestinal obstruction.   1, Laparotomy performed. An operable carcinoma of the pelvic colon was found.   Laparotomy wound closed. 2, Cæcostomy incision.   The cæcum was found to be bound down and could not be delivered, therefore this wound was also closed.   3, Transverse colostomy performed.   (The incisions 1 and 2 have protective dressings tied on.)

cæcostomy tube, when Lockhart-Mummery's technique is employed, usually functions for about a week before it becomes loose.   A cæcostomy performed in this way often closes spontaneously when the cause of the obstruction has been removed.

Colostomy : Left Inguinal.—

Technique. –Stand on the left side of the patient.   An incision is made like that for appendicectomy by the gridiron method, but on the left side (*Fig.* 180).   The external oblique is incised and the

internal oblique split. The peritoneum is opened. Four hæmostats are placed on the peritoneum in such a way that they are comparable to the four points of the compass. The pelvic colon is now sought for, and it is readily distinguished from small intestine by its tæniæ and its appendices epiploicæ. The colon is delivered, and its upper end is gently drawn down until it feels taut a measure which considerably reduces subsequent prolapse of mucous membrane. If, after [this has been done, there is too much colon on the surface for our purpose, some of the *inferior end* of the loop is tucked back into the abdomen. A spigot is now passed through the mesentery under vision (*Figs.* 181, 182). The next step is to stitch the peritoneum to the bowel at the four points of the compass. The hæmostats

Fig. 180.—Incision for left

previously applied serve to mark these points and render the peritoneum accessible to the needle. An extra stitch on the medial side is an advantage. The external oblique is brought together above and below the loop, the skin is sutured in the same way. If time is not an all-important factor, the appendices epiploicæ may be picked up with forceps, ligatured at their base, and removed. The whole area is now swabbed with iodine. A vaseline-smeared abdominal pad with a hole in it (*see* p. 204) is arranged to protect the wound. A purse-string is introduced and a large Paul's tube tied into the gut.

Difficulties and Dangers.—

1. It is necessary to *see that the loop withdrawn is not twisted* on its axis. This can easily be guarded against by examining the mesentery by sight and touch.

2. *If the colon cannot be withdrawn*, the wound is enlarged slightly, and by incising the peritoneum on the outer side of the colon, the mesentery can to some extent be mobilized. Mobilization is carried out by gauze dissection in the loose areolar tissue under the peritoneum. This method often acts admirably, but it is dangerous when the gut is distended. If the patient is fat, the mesentery short, and the gut ballooned, the best practice is to close the incision and perform transverse colostomy.

Fig. 181. Vulcanite spigot. After insertion the ends of a length of rubber tubing of suitable size are placed over each end of the spigot, which is then prevented from becoming dis-

Fig. 182. Left inguinal colostomy. Passing the spigot through the mesentery.

3. Do not economize time by *neglecting to sew the peritoneum to the bowel*. I have been called upon to treat two cases where this step had been omitted. In the first a small loop of intestine became herniated through the peritoneum, and on the fifth day caused (renewed) acute intestinal obstruction. In the second case coils of small intestine prolapsed right out on to the abdominal wall.

4. If *solid fæces are present in the colon above the growth* it is highly improbable that the colostomy will function for a considerable period. If it is imperative for the colon to be drained immediately, transverse colostomy is a better operation.

Blind Left Inguinal Colostomy (colostomy without exploration of the abdomen).—This is justifiable and indicated : (*a*) In the aged, when the diagnosis of carcinoma of the pelvic colon is practically certain ; and (*b*) In acute on chronic obstruction when an inoperable carcinoma can be felt with a finger in the rectum.

In the case of (*a*) the diagnosis can be confirmed when the peritoneum has been opened prior to performing a colostomy. If the growth cannot be felt, or if the pelvic colon is collapsed, the colostomy should on no account be persisted in. If the growth cannot be felt, the abdomen must be explored through a right lower paramedian incision.

Fig. 183.—Transverse colostomy

Colostomy : Transverse —

Technique.—A vertical incision about $3\frac{1}{2}$ in. long is made immediately above the umbilicus and about an inch to the right of the middle line. The incision is deepened and the rectus sheath opened. The fibres of the rectus muscle are split. The peritoneum is opened. The distended colon is usually located without the slightest difficulty. A loop is withdrawn and a spigot passed through the mesocolon (*Fig.* 183). The peritoneum is stitched to the colon at each side, after which the peritoneal incision is closed above and below the loop, the bowel being anchored to the peritoneum in the process. The rectus sheath is closed above and below by interrupted stitches. If we are

not very certain that the peritoneum has been sutured to the bowel satisfactorily, the rectus sheath may be stitched to the loop. The skin is closed. Redundant transverse mesocolon is clamped, ligatured in sections near its base, and removed. A *large* Paul's tube is tied into the apex of the loop, following the technique described on p. 204.

Transverse colostomy is an excellent operation. It has the advantage of a cæcostomy in that it commences to drain soon after the operation, because the contents are liquid. The skin does not become excoriated, as so often happens after cæcostomy. A transverse colostomy belt fits snugly and is always satisfactory.

Indications for Transverse Colostomy.

1. Inoperable carcinoma of the splenic flexure, descending colon, and pelvic colon (when fixed).

2. Carcinoma of the pelvic colon and rectum when solid fæces can be palpated above the obstruction.

3. When left inguinal colostomy is not possible because of a short mesentery.

4. When cæcostomy is not advisable because of adhesions around the cæcum or fixity of that organ.

Blind Transverse Colostomy. If the general condition of the patient is so poor that we desire to drain the large intestine and nothing more, blind transverse colostomy (*Fig.* 184) has two great advantages to offer:

1. If the patient recovers from the acute obstruction, in fully 50 per cent of cases the growth will eventually prove to be inoperable, in which case the transverse colostomy is as good a permanent colostomy as any.

2. The only really common sites for a growth of the colon are the pelvic colon and the splenic flexure, which means that, if blind transverse colostomy is contemplated, there is every chance of being above the obstruction.

Fig. 184.

for acute intesti
Through the incisio
          s palpated. H
          tomy to be per
    i the usual manner.

Method of Inserting a Paul's Tube (Cæcostomy and Colostomy). — A dry abdominal pad is taken and its tape cut off. One surface of the pad is spread lightly with sterile vaseline. The handle of an aneurysm needle makes a convenient spreader. The pad is now folded into four, the vaselined surface being inverted. The folded corner is then cut off (*Fig.* 185 — inset). On opening the pad a circular hole will be found in its centre (*Fig.* 185). The pad, vaseline side downwards, is now laid over the colostomy and the colon brought
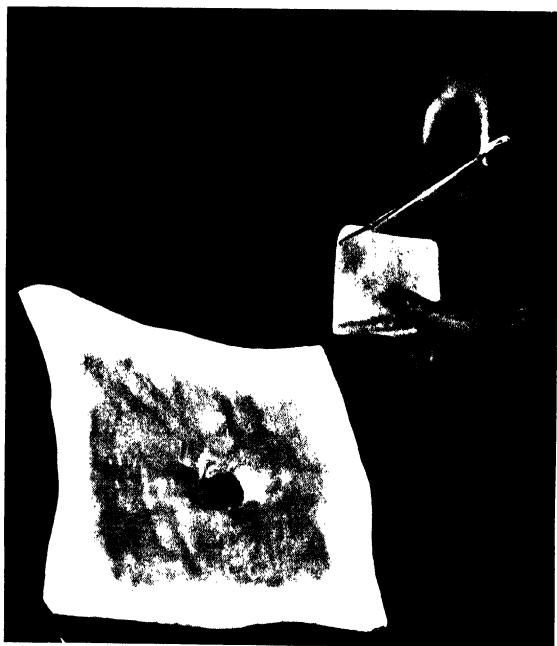
Fig. 185. — Method of making a vaselined protective coverin for use around a colostomy or cæcostomy.

up through the hole. A purse-string suture is inserted. Within the encircling purse-string the gut is picked up with two hæmostats. Swabs are placed on each side, and the assistant holds one in his hand ready to mop up any escaping fæces. A small incision is made into the gut between the two hæmostats, which are held fairly taut in a directly upward direction. This small incision is dilated very gently by opening the jaws of a third pair of forceps. The edge of the opening is now clipped by this third pair of forceps, which is handed to the assistant, and a Paul's tube is insinuated into the

incision (*Fig.* 186). The Paul's tube should pass into the gut right above its second bevel, when the purse-string is tied. Between the first and second bevels a piece of tape is tied tightly (*Fig.* 187). Tape is a most useful material for keeping a Paul's tube firmly in position.
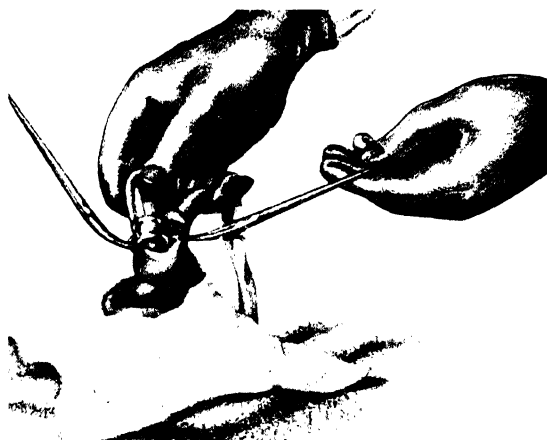
Paul's tube
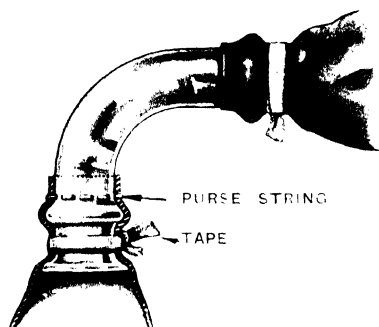
Fig. 187.   Tying in a Paul's tube.

Method of Protecting a Laparotomy Wound from the Infection of the Colostomy : Making a ' Watershed.'—A strip of broad adhesive plaster about 6 in. long is taken, and the assistant takes a similar piece of exactly the same length. Facing one another, and working independently but simultaneously, both the surgeon and the assistant

fold their piece of plaster longitudinally (*Fig.* 188, A). The surgeon now approaches the assistant, and the strips of plaster are placed back to back (B and C). The surgeon then takes both pieces, the
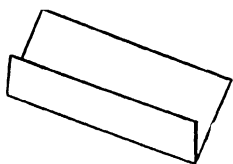
A   B   C   D

Fig. 188.—Making a 'watershed'. A. Method in which the strips of adhesive plaster are folded ; B, Approximation of the strips held by the surgeon and assistant ; C, The strips approximated ; C, The 'watershed' applied to the abdomen.

backs of which have adhered to one another, and applies the 'watershed' to the abdominal wall between the two wounds (D). *Fig.* 189 shows the 'watershed' in action. In addition to preventing fæcal

Fig. 189.—' Watershed ' in action.

contamination of the laparotomy wound, it serves to remind the nurse that the two dressings must be kept separate.

    Note.—Rubber gloves should be removed before handling the strapping—the plaster adheres so readily to the rubber.

Paul's Operation. --The essential principle of Paul's operation (*Fig.* 190) is that the portion of bowel containing the growth is brought outside. The indications for the use of this operation in cases of acute intestinal obstruction are, I believe, exceedingly limited. It might be used when that portion of the colon containing the growth is excessively

Fig. 190. Paul's operation. The growth is situated at **A**. The two limbs are stitched together whenever possible, as shown in the figure. The colon must be very mobile for this operation to be performed.

mobile and the patient so feeble or old that he is unlikely to stand resection and anastomosis at a later date. The operation should be borne in mind for this very exceptional combination of circumstances. I have also used the method when the growth had perforated or was on the point of perforation.

VOLVULUS OF THE LARGE INTESTINE

Volvulus of the Cæcum. --Volvulus of the cæcum is not a very rare condition. In England it is probably more common than volvulus of the sigmoid. In the majority of instances the ileocolic junction twists upon an abnormal mesenteric axis. The distension is not so great as in volvulus of the sigmoid. These cæcal torsions rarely exceed 80°, and can usually be untwisted. To prevent recurrence the outer side of the cæcum may be anchored to the fascia overlying the iliacus.

Gangrene has been found in several recorded cases. If the gangrene is extensive, resection of the cæcum, with ileocolic anastomosis, is the only possible course. In minor degrees a gangrenous patch may be invaginated, in which event it is a wise precaution to

perform cæcostomy. Maunsell wisely pointed out that appendicostomy or cæcostomy performs a dual service. It drains the affected gut and *it fixes the cæcum, thus preventing a recurrence.*

Volvulus of the Sigmoid.— In some parts of Russia and Eastern Europe,* volvulus of the sigmoid accounts for over one-third of all cases of intestinal obstruction; but in this country the condition is quite rare.

There is usually a history, dating back for some time, of attacks of abdominal pain with constipation, followed by diarrhœa and the passage of a large quantity of flatus. These attacks are obviously due to twists which undergo spontaneous rectification.

A Russian Jew, aged 27, was admitted with severe abdominal pain. His bowels had not moved for three days, but for him this was not an unusual occurrence. Examination of the abdomen showed a large resonant tumour arising from the left iliac fossa. An enema gave no result. The diagnosis of volvulus of the sigmoid seemed quite evident, and operation was advised. He took the anæsthetic badly. While struggling and shouting during the early stages of induction, he passed a quantity of flatus followed by a fluid motion. The anæsthetic was therefore discontinued. The resonant tumour disappeared. Next day he felt quite well, and refused to stay in hospital.

The usual mental picture of volvulus of the sigmoid is one of very acute intestinal obstruction with a rapid and enormous abdominal distension—a distension so great that it may cause respiratory embarrassment. " While there can be no doubt that the final attack is of this type, it is becoming increasingly recognized that long before this takes place there may be symptoms of a more chronic or recurrent type " (Garnett Wright).

When the symptoms of volvulus of the sigmoid are not hyperacute, Tanner recommends, and has practised successfully, the passage of a rectal tube *with the aid of a sigmoidoscope.* If the tube can be manœuvred beyond the obstruction, it is left in position and the colon can be thoroughly irrigated and cleansed preparatory to a set operation a few days later. With the patient in good condition and the colon empty, resection and anastomosis can be performed. This is the most satisfactory measure, for it is quite clear that volvulus of the sigmoid is a recurrent condition. A patient of Dr. Blake was operated upon for acute volvulus of the sigmoid on no less than four occasions (Barnard).

Treatment of Acute Volvulus of the Sigmoid.—Sigmoidoscopy, and an endeavour to pass a rectal tube by its aid, is certainly worth a trial in many cases. If unsuccessful, the tube may be left in the rectum ready for an assistant to manipulate when required.

* In a series of 318 cases of intestinal obstruction reported at the Southern Slavonic Congress of Surgery, no fewer than 130 were due to volvulus (quoted in *Jour. de Chir.*, 1912, Jan.).

The abdomen is opened by a left lower paramedian incision, and the volvulus delivered. Using both hands (*Fig.* 191), untwisting is attempted, at first in a clockwise direction. Should the pedicle be visible, one can see in which direction it is necessary to turn; if on account of distension the pedicle cannot be seen, one must use the method of trial. If untwisting is possible, the rectal tube already in position is manœuvred past the obstruction, the gas is evacuated via the tube, and the abdomen is closed. McAdam Eccles writes:

Fig. 191.—Unwinding a volvulus of the sigmoid.

" When the abdomen has been opened and the volvulus of the pelvic colon has been untwisted, the passage of two œsophageal catheters through the natural anus and up into the part of the pelvic colon which has been the site of the twist will drain the loop and allow fluids to be injected through one catheter and to escape through the other."

If untwisting is at first impossible, or dangerous on account of extreme distension and impending rupture of the loop, it may yield after evacuation of the gas. The loop is punctured through one of

the tæniæ coli with a fine cannula or an aspirating needle. In order to close the puncture after the gas has been evacuated, a purse-string is inserted just before the cannula is removed.

If the volvulus cannot be untwisted, a very rare event, a large catheter may be tied into its apex and a cæcostomy performed to relieve the intestinal obstruction. This method is adopted to tide the patient over until he is in a fit state to stand resection of the pelvic colon.

Gangrene of the Loop. Unless the general condition of the patient is fairly good, resection should be temporarily avoided if possible. If there are merely gangrenous patches, these may be invaginated. If a large area is involved, Paul's operation might be practised with advantage. The loop, which is always mobile, could be brought to the surface, a spigot placed through the mesentery, and a Paul's tube tied in on the convex border. Resection could then be undertaken if the patient survived. If the general condition of the patient permits, a resection, with Paul's tubes tied into each end, may be practised.

SUMMARY. Volvulus of the sigmoid is a recurrent condition. The simplest method which can tide the patient over the acute attack of obstruction should be employed. If this can be done without opening the abdomen, so much the better. When the attack is over and the colon is clean, resection of the mobile loop and anastomosis can be undertaken with comparative safety, and is the one measure which will guard against recurrence.

MESENTERIC OCCLUSION AFFECTING THE LARGE INTESTINE

If the large intestine is the seat of the infarction the prognosis is very poor indeed. Perhaps the variety most amenable to treatment is that in which a segment of the transverse colon is involved (middle colic artery).

Infarction of the Transverse Colon. Resect the gangrenous area widely. Close both ends of the intestine. Perform cæcostomy.

Infarction of the Right Half of the Colon. Resect the cæcum and ascending colon as far as is necessary. Perform ileocolostomy.

Infarction of the Left Half of the Colon. This is exceedingly rare. If localized, it could be treated by excision and the insertion of Paul's tubes. Alternatively, Paul's operation might be practised.

ACUTE INTESTINAL OBSTRUCTION DUE TO PATHOLOGICAL CONDITIONS OF THE RECTUM

The causes of acute obstruction so far as the rectum is concerned may be summarized as follows :—

(1) Malignant disease ; (2) Simple stricture of the rectum ; (3) Obturation by gall-stone, stercolith, or foreign body ; (4) Impaction of faeces.

1. Malignant Disease. If malignant disease has proceeded so far as to cause acute intestinal obstruction, the growth is nearly always inoperable, and a left inguinal colostomy is indicated. An exception to the rule is a ring carcinoma of the recto-sigmoidal junction, which causes obstructive symptoms comparatively early. In this type of case the obstruction may sometimes be relieved by passing a rectal tube through a sigmoidoscope. If the rectal tube can be insinuated through the stricture, it is anchored to the anus by a stitch. It can be left in place several days, and allows the colon to be washed out, an excellent preparatory treatment for an operation designed to remove the growth, should it prove operable when the abdomen has been opened.

2. Simple Stricture of the Rectum.

E. W., a girl of 17, was admitted with acute intestinal obstruction. For eight years she had suffered from severe constipation : the bowels rarely moved without purgatives. For the past fourteen days she had been in much pain and had vomited repeatedly. The constipation had continued throughout all this period, in spite of enemas and purgatives. Examination showed drum-like distension of the abdomen, and she was obviously very ill. The pulse-rate was 132 and the temperature subnormal. Two inches within the anal canal a tight stricture could be felt which just admitted the tip of the finger. Under spinal anaesthesia the stricture was stretched so as to admit four fingers. Faeces were removed. Enemata produced copious results for some days. Recovery.

This stricture must have been congenital—a semi-imperforate anus. More often the stricture is inflammatory.

It is important to arrange for periodic dilatation of a stricture after the patient has been discharged.

3. Impaction of Foreign Bodies.—

Stercolith in the Rectum.

An old woman 72 years of age was admitted with ' acute on chronic ' intestinal obstruction. The abdomen was greatly distended and the caecum hyper-resonant. A hard body could be felt in the rectum. Under anaesthesia the sphincter was stretched, and liquid faeces poured forth. An attempt was made to grasp the body with the forceps which are used to introduce Champetier de Ribes' bag, but this was not successful. The body was eventually delivered grasped between a scoop and the index finger of the left hand, and was found to be a stone-like body the size of a tangerine orange (the nucleus may have been a gall-stone). Recovery.

For delivery of a foreign body of this character a dessert-spoon would have been a very useful instrument.

Gall-stone in the Rectum.

A man of 57 was admitted with subacute intestinal obstruction, which responded to enemata. A year before the patient had been under treatment for gall-stone colic accompanied by jaundice, but he had refused operative treatment. It was therefore reasonable to conclude that the body which was felt was a gall-stone. The next day a sigmoidoscope was introduced and the body was seen, but with the air inflation it moved farther and farther up the colon, and was quite out of reach. An incision was therefore made in the left iliac fossa and the stone was pushed down into the rectum, where it was delivered by an assistant. The stone is shown in *Fig.* 192. The gall-bladder contained one very large calculus, but as the condition of the patient was poor, this was not removed.
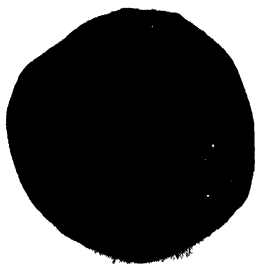
Fig. 192.- Gall-stone which caused obstruction, removed from the rectum. (¾.)

4. Fæcal Impaction. The disimpaction of fæces is a necessary, but most distasteful, surgical task. Many of these patients have a fissure in ano, and as it is necessary to stretch the sphincter thoroughly in order to remove the accumulation, the fissure (which is probably the starting point of the vicious circle) is cured at the same time. A spoon is a useful instrument with which to remove the mass.

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CHAPTER XV

OBSTRUCTION OF THE SMALL GUT: GENERAL EMERGENCY MEASURES

Treatment of Annular Gangrene of the Small Intestine by Invagination.
—" Experience has taught me that when the gangrene is limited and annular in type it may be handled more safely by invagination than by resection." (*Summers.*) It is seldom that a typical case is presented in which this method is indicated, but there is little doubt that invagination in properly selected cases will save many lives.

Invagination is *contra-indicated* in the following conditions: (1) When the loop of gangrenous intestine is longer than three inches;
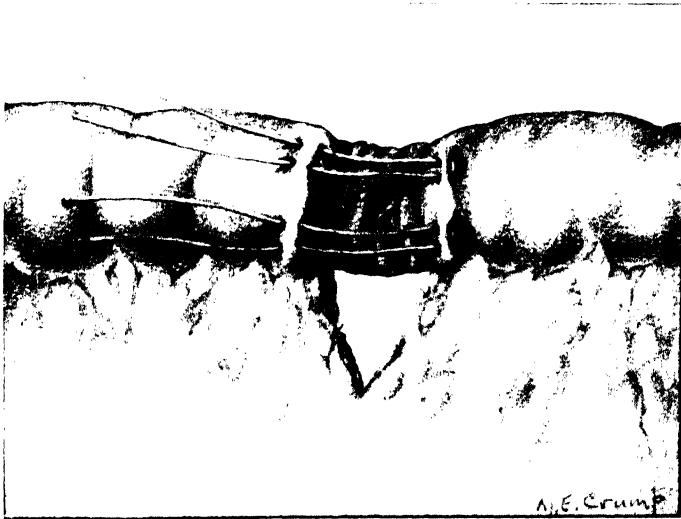
Fig. 193. Treatment of localized annular gangrene (1). A V-shaped piece of mesentery is excised and mattress sutures are placed as shown.

(2) When there is much œdema of the intestinal wall; (3) When the gut above is very dilated and the gut below collapsed. These contra-indications must be noted carefully. I have attempted to invaginate an œdematous piece of gut, but when the invagination was completed it was obvious that the lumen was practically blocked, so that resection had to be undertaken after all.

The technique of invagination is illustrated in *Figs. 193, 194.*   A
V-shaped piece of mesentery, the base of which corresponds to the
gangrenous portion, is excised.   By means of four sutures, applied
as shown, the gangrenous portion is tucked in.   A single intestinal
suture completes the anastomosis all the way round the periphery,
and the gap in the mesentery is closed.

The type of case in which the invagination may be used occurs
particularly in strangulated femoral hernia, and if Lotheisen's method
has been used there will be no difficulty in returning the somewhat
bulky segment into the peritoneum.   When the method is employed
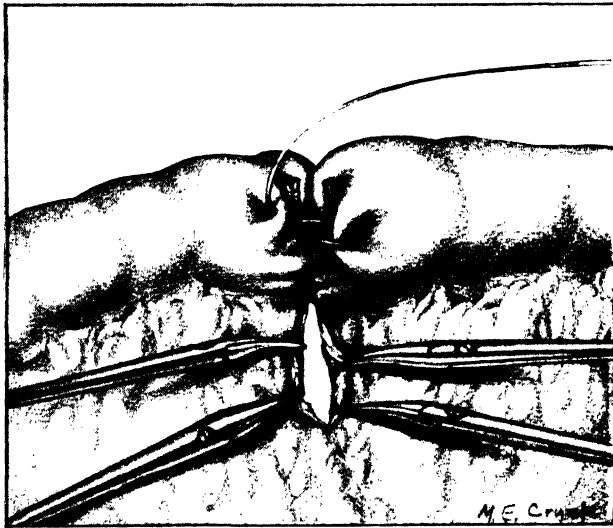
*Fig. 194.—Treatment of localized annular gangrene (II).   A single intestinal
suture all the way round the periphery, taking frequent back-stitches, is inserted,
and the hole in the mesentery is closed.*

in connection with inguinal hernia, one must be sure that the con-
stricting ring is dilated widely before attempting to return the loop.
If this has to be pushed through a narrow neck, the line of suture
may be disturbed.

Exteriorization or Resection and Anastomosis? —Except in the very
limited class of case quoted above, *it is imperative in every instance to
resect widely non-viable gut.   It is not imperative to perform an immediate
anastomosis*, indeed, when the proximal intestine is much dilated and
the condition of the patient is poor, exteriorization of non-viable
intestine is sometimes to be preferred in the first instance.

Exteriorization of Gangrenous Gut.—The devitalized segment is brought out through the incision, and the abdominal wall is closed around it. The skin is approximated and mattress skin sutures are passed so as to include the mesentery. After clamping lightly with an intestinal clamp placed almost flush with the skin the exteriorized gut is excised, leaving half an inch protruding above the surface. Into each end a catheter is stitched in such a way that it fits snugly near the antimesenteric border. A few bleeding vessels in the cut mesentery will need ligating.

It is possible to collect intestinal contents escaping from the proximal end and to introduce them into the distal end. After about six days the catheter in the proximal end tends to become loose, and it is at this time, if the patient's condition allows, that a secondary anastomosis is performed.

In the case of strangulated external herniae, where the gut and the condition of the patient fulfills the conditions warranting exteriorization, Wangensteen advises that the devitalized loop of intestine be brought through a separate short mid-line sub-umbilical incision.

Resection of Gut.—It is as easy to resect two feet as two inches. This is important when deciding upon the points of the proposed section; one can afford to err on the side of liberality, for an extra few inches resected often ensures healthy intestine for anastomosis.
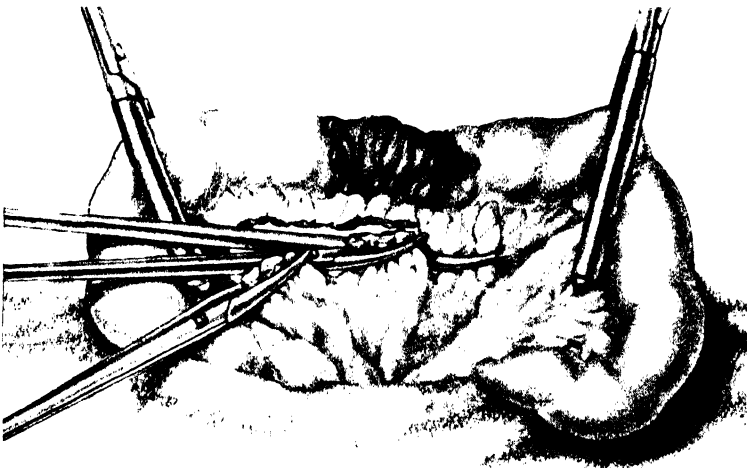
A. C. Crump.

Fig. 195. Resection of gut. The first step is to divide the mesentery.

Having decided how much to resect, a rubber-covered clamp is placed on the distal point ; then, stripping back the intestinal contents, the second clamp is applied at the proximal point. The arc to be resected is isolated carefully with moist towels.

The first step is to divide the mesentery. At the lowermost point of the proposed section a sharp-nosed hæmostat is driven through the mesentery near the gut (choosing a comparatively avascular spot if possible). Clipping, then cutting, the mesentery is freed from the intestine (*Fig.* 195). Then the mesentery is tied off. Each hæmostat is picked up in turn, and the mesentery which it grasps is transfixed and ligatured.

A crushing clamp is applied at each end of the free segment. The point at which the crushing clamp is applied must have a good blood-supply — in other words, it should be hard up to that portion of the intestine which has its mesentery still intact.

Fig. 196. The relative positions of the and the crushing instrument. Note that th ing instrument is applied near the intact me

Fig. 196 shows the relative positions of the rubber-covered clamp and the crushing instrument. A length of gauze is tucked under the mobilized gut, hiding and protecting the divided mesentery. In order to prevent escape of intestinal contents at each end a large-sized hæmostat is applied close up to the crushing clamp (*Fig.* 197). A scalpel run down the surface of each crushing clamp immediately frees the portion to be resected (*Fig.* 198). This, with the scalpel which freed it, is cast into a bowl away from the field of operation. The surface of the clamp which the scalpel had traversed is swabbed lightly with iodine.

I am well aware of the advantages of the cautery for dividing intestine ; but if one is not in possession of a really efficient electrical instrument, and has to use a Paquelin cautery, the time expended in waiting for the latter to be brought, and the disappointments connected with its use when only semi-skilled assistance is at hand, have driven me to advise, in an emergency, the above method, which is rapid and has served me well.

Fig. 197. — Excising the segment of intestine
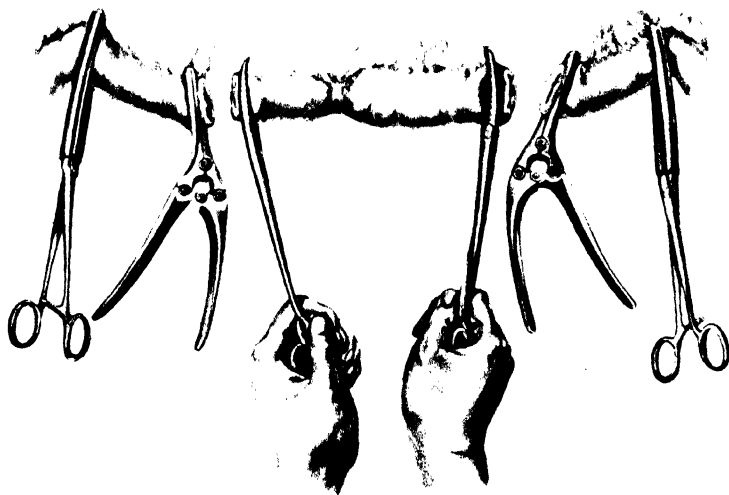
Fig. 198. —Relative position of instruments during excision of a segment of gut.

End-to-end Anastomosis.— The crushing cla p is removed and the end of the gut will be found to be sealed. This sealed, crushed surface is picked up with hæmostats at each end and the edges are prised apart with a Watson Cheyne dissector. The interior of the gut is swabbed dry with gauze (*Fig.* 199), and a little
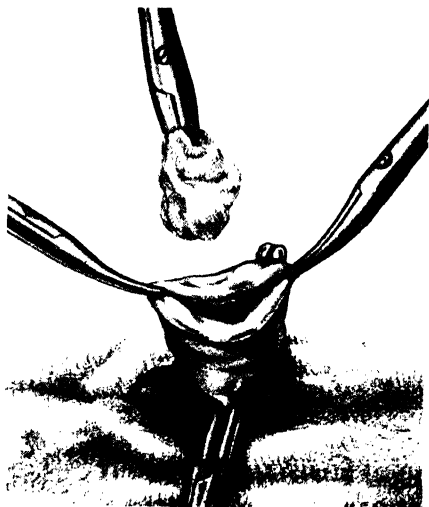
Fig. 199. Swabbing out the interior of the gut distal to the clamp, preparatory to anastomosis. After the intestinal contents have been removed, a little iodine is used to sterilize the gut edges.

iodine is applied within and to the edges. The proximal segment requires more attention in this respect than the distal, which, being empty, must be comparatively sterile.

The technique about to be described is Shelton Horsley's, which in the opinion of the present writer is a distinct advance on older methods :

1. The little triangle at the junction of the gut and its mesentery which has so well earned the name of the 'danger area' (*Fig.* 200) is picked up in a hæmostat, crushed, and ligatured.

2 Two well-soaked intestinal catgut sutures with eyeless needles are taken and their free ends knotted. The knot should be trimmed and tested.

up in a hæi

3. The rubber-covered clamps are brought together and adjusted so that the cut surfaces of the intestine lie parallel with one another. Both needles of the intestinal suture just mentioned are passed close to one another through the whole thicknesses of the gut and a knot is tied. *Fig.* 201 will make this clear.

4. From this fixed point each needle with its suture is used to stitch one half of the circumference of the intestine, the lowermost
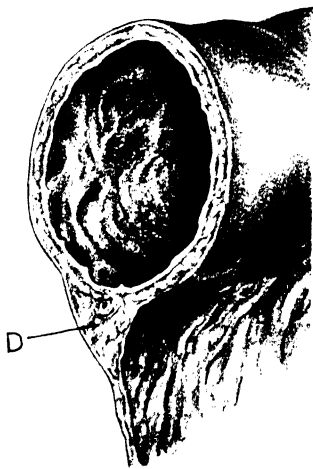
side being stitched first (*Fig. 202*). The stitches pass through the whole thicknesses of the gut and are of the over-and-over type, but a back-stitch is taken every fourth or fifth in order to lock

Fig. 201.—End-to-end anastomosis. The first stitch, which is placed to on side of the ligatured danger area, is shown.

Fig. 202.—End-to-end anastomosis. The posterior layer completed. Th stitch passes through all coats of the intestine.

Fig. 203.—End-to-end anastomosis. The anterior row is completed and meets its fellow suture at a point diametrically opposite the first stitch.

the line of suture and prevent a purse-string effect with its inevitable narrowing of the loop.

5. The stitching is completed at a point diametrically opposite the point at which it was begun (*Fig.* 203). A knot is tied. The needles pass finally through the serosal and muscular coats, over the knot, and a last knot is tied burying the former (*Fig.* 204).

Fig. 204.—End-to-end anastomosis completed by burying the knot

If the case is a very urgent one, this single suture is all that is necessary, but usually a second row is inserted around the entire circumference, using a Connell stitch, locking it with a back-stitch frequently.

Closing the Gap in the Mesentery.—If a needle is passed through the mesentery, there is always the danger of pricking a blood-vessel and thereby imperilling the vitality of the gut. A better method is illustrated in *Fig.* 205. One ligature is thrown around two pairs of forceps, one pair being applied to each cut surface. Two or three ligatures tied in this way will close the gap in the mesentery effectively.

Fig. 205.—Closing the hole in the mesentery. This is a better method than using a needle, which may pierce a blood-vessel.

Ileocæcostomy.—Ileocæcostomy is lateral anastomosis at its best. It is indicated particularly when it has been necessary to resect gut

in the lower third of the ileum. It is a method which can be safely resorted to in every case where the portion of gut to be resected comes within a foot or so of the ileocæcal valve. The resection of an extra foot of contracted intestine is a matter of a moment, and the gain is an anastomosis which one feels confident will function if there is even the feeblest peristaltic action. The loss of the ileocæcal valve does not appear to be of any consequence. I have observed patients over long periods (up to eight years) who have had this form of anastomosis performed, and they had no irregularity or discomfort of bowel action. For the lower ileum this form of resection and anastomosis is second to none.

Technique.— Using the method shown in *Fig.* 195 (*see* p. 215), the small gut is resected to within an inch of the ileocæcal valve. It is here crushed, ligatured, and the stump invaginated into the cæcum, just like the stump of an appendix. The proximal end of the small intestine is also closed and invaginated. A gastric clamp is then taken and applied to

Fig. 206.—Ileocæcostomy. Completion of the posterior sero-muscular suture.

the anterior cæcal wall. About three inches of the cæcum is grasped by the clamp, and care taken to avoid the inverted stump of small intestine. The invaginated end of the ileum is laid along the medial border of the clamped portion of the cæcum in such a manner as to make the blind end point towards the hepatic flexure. Having stripped the contents backwards carefully, a smaller clamp is applied transversely about five inches from the blind extremity—a second

clamp may be applied beyond this for safety. A strip of gauze is
tucked under the portions of intestine to be anastomosed, and the
whole area carefully isolated with towels. The anastomosis is carried
out by the four-stitch method
so well-known in gastro-enter-
ostomy (*Fig.* 206). When the
gut is opened, the mucosa is
cleansed carefully. After the
anastomosis has been completed
(*Fig.* 207), the clamps are re-
moved and the suture line is
covered with omentum if this
is available.

Fig. 207.—Ileocæcostomy. Anastomosis
completed.

**Emptying the Distended
Intestine above the Obstruction.**
—When there is difficulty in
finding the obstruction, eviscer-
ation usually simplifies the
search, but Holden advises
this measure principally in
order that the gut may be
emptied, which he does in the
following manner. The intes-
tine having been clamped tem-
porarily as near to the obstruc-
tion as possible, the loop is
carefully emptied of its con-
tents as described on p. 226.
A purse-string of stout silk is
inserted.   Holden inserts a glass tube. I think a malecot catheter
has certain advantages. Only the first half of the knot is tied ;
the suture is then clamped tight with a hæmostat. The contents
of the obstructed intestine are then evacuated in the manner shown
in *Fig.* 208. When the intestine has been emptied sufficiently the
catheter is removed and the opening closed by drawing tight the
purse string.

The method is, of course, contra-indicated in the presence of
peritonitis. In the absence of peritonitis it is successful only if the
greatest precautions are taken to avoid contamination of the peri-
toneum. The loop containing the catheter must be isolated scrupul-
ously with abdominal packs. Although I have employed successfully
Holden's method on a number of occasions, I am inclined to think
that it should be used only exceptionally, viz. :—

1. If the distension is too great for the obstruction to be found.

2. When the distension is so great that it is improbable that the abdominal wall can be repaired without undue trauma and waste of time.
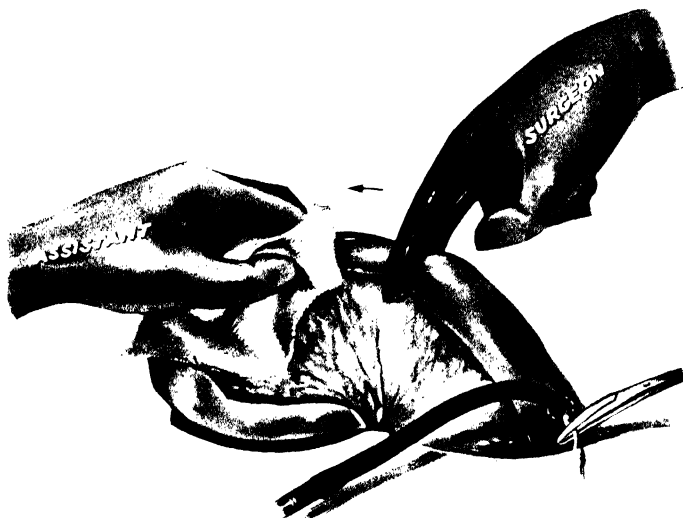
Fig. 208.   Emptying the distended small intestine by Holden's method. The surgeon's fingers are dipped in liquid paraffin.

Anastomosis of a Dilated with a Collapsed Loop.   In complicated obstruction, when the condition of the patient will not permit of the operation being prolonged beyond the bare minimum of time, anastomosis of a conveniently placed dilated loop with an obviously collapsed loop has many times proved to be a means of saving life.

E. R., aged 30, four years previously had acute appendicitis with drainage. One year previously I had opened his abdomen at the forty-eighth hour for acute intestinal obstruction by a band. On this second occasion he was admitted with typical intestinal obstruction of four days' duration, and his general condition was poor. The abdomen was opened by a left paramedian incision (to avoid the scar tissues of previous operations). The interior was a mass of adhesions. Some of these were separated, but the main trouble seemed to lie where the gut was adherent to the abdominal wall. His condition was so poor that it was imperative to finish the operation as quickly as possible. A collapsed and obviously contracted loop was anastomosed to a dilated loop. Recovery.

I watched this patient for two years. Every few months he had an attack of severe abdominal pain which usually passed off in a few hours. After an unusually severe bout I advised him to have further operative treatment. Through an upper abdominal incision the

small intestine was run through the fingers until the obstructed area
was reached. The ileum was then divided completely at a convenient
point, and after closing the ends lateral ileotransverse colostomy was
performed. The result was perfectly satisfactory.

To summarize : Anastomosis of a collapsed to a dilated loop
sometimes proves to be the only method available. The end-results
cannot be said to be always satisfactory, and further operative
measures may be necessary.

JEJUNOSTOMY

While admitting that jejunostomy is sometimes a life-saving
measure, it is necessary to emphasize that the need for this emergency
measure has grown less since the value of gastric aspiration, par-
ticularly continuous gastric aspiration
(p. 101), has received the attention it
deserves.
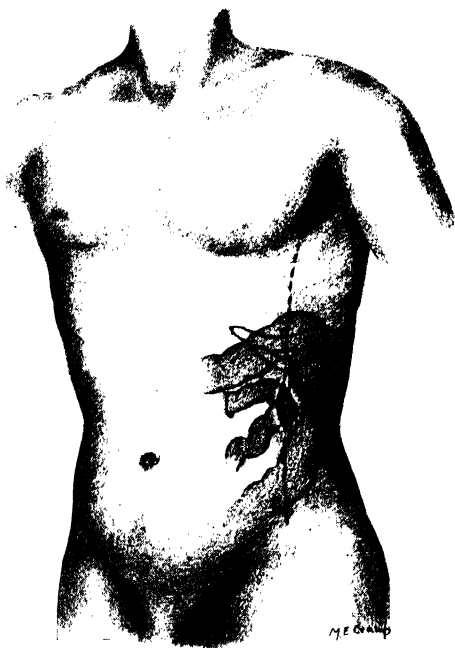
Fig. 209.—Jejunostomy. The incision is
made at the level of the tip of the eleventh rib
in the anterior axillary line.
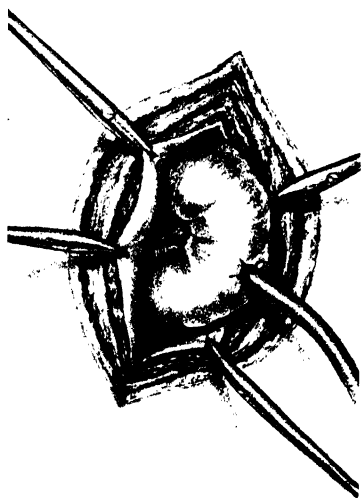
Fig. 210. Jejunostomy. A cath-
eter has been sewn into the jejunum;
the peritoneum is about to be stitched
to the apex of the loop.

The indications for jejunostomy are difficult to assess. The
following list epitomizes the position.

1. In acute intestinal obstruction, when the patient is too ill to warrant exploration.

2. When paralytic ileus has not responded to conservative treatment, or actual obstruction by multiple kinks has supervened.

3. After suture of a perforated large gastrojejunal ulcer, in order that the patient may receive nourishment below the diseased area.

4. Jejunostomy is recommended by some as an adjuvant measure in the treatment of general peritonitis.

Technique (Ravdin's method). The following is a universal method for performing jejunostomy. It can be used as a supplementary measure or as a primary operation intended to relieve a patient in the throes of faecal vomiting; if absolutely necessary it can be performed in the patient's bed. Local infiltration anaesthesia is used. An incision not more than two inches long is made just posterior to a prolongation of the anterior axillary line, beginning at the tip of the eleventh costal cartilage (*Fig.* 209). The incision is carried down to the peritoneum through the external oblique, internal oblique, and transversalis muscles, with no regard to the direction of their fibres. The peritoneum is opened for a distance of about one inch. In the majority of cases a high loop of jejunum presents immediately. When this is not the case the coil is retrieved by insinuating the finger just anterior to the upper portion of the descending colon. The coil is withdrawn and clamped lightly. A No. 14 rubber catheter, preferably self-retaining, is then stitched into the bowel, using Wangensteen's technique (*see* p. 226). The apex of the loop containing the catheter is then stitched with several sutures to the parietal peritoneum (*Fig.* 210). It is sometimes unnecessary to suture the muscle layers—they will be found to fall together; in any case they should be approximated but lightly. The skin is then closed about the tube, taking the precautions shown in *Fig.* 211.
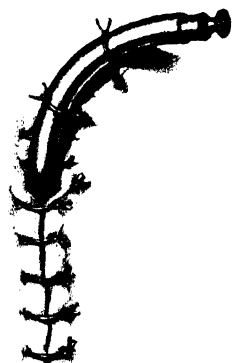
Fig. 211.— Jejun ... ted. In addit nchoring stitch heter two skin ped round the nner shown. Tl essary precautior prevent ut acci- dentally. (*After Ad.*

When the patient is back in bed, the jejunostomy tube is, by means of a glass connection and a short length of soft rubber tubing, led into a receptacle. It is unwise to have a long tube leading down the side of the bed, for its weight angulates the catheter at a

point near its exit from the dressings. Six ounces of sodium bicarbonate solution may be run into the intestine at intervals, and the escape of intestinal contents encouraged by siphonage (*Fig. 212*). As

Fig. 212. Jejunostomy in grave intestinal obstruction. A solution of sodium bicarbonate is being run into the intestine in order to encourage the escape of intestinal contents by siphonage.

soon as the outflow from the tube ceases to be foul-smelling, the tube can be clamped. In ten days or more the catheter can be removed. Usually the opening closes spontaneously.

Enterostomy.—For the most part enterostomy is an alternative to jejunostomy. I am not enthusiastic about either procedure unless conditions make it imperative to drain the small intestine. Of the two, I have had more success with enterostomy. The principal indication is post-operative obstruction following peritonitis.

The best incision for primary enterostomy is a grid-iron incision in the left iliac fossa. Whenever a catheter is to be sewn into the intestine Wangensteen's modification of Witzel's operation is the method of choice, for it obviates spilling the intestinal contents—one drop of which is sufficient to set up fatal peritonitis.

Wangensteen's Modification of Witzel's Operation.—A coil of distended ileum is withdrawn and isolated carefully with abdominal pads. The coil must be emptied. When only moderately distended the contents can be milked back and rubber-covered intestinal clamps applied. If the distension is considerable, clamping followed by aspiration (*Fig. 213*) is a better method. Only if the coil is emptied

thoroughly can the catheter be introduced without risk. The needles and suture material should be fine (No. 000 catgut). A No. 14 French
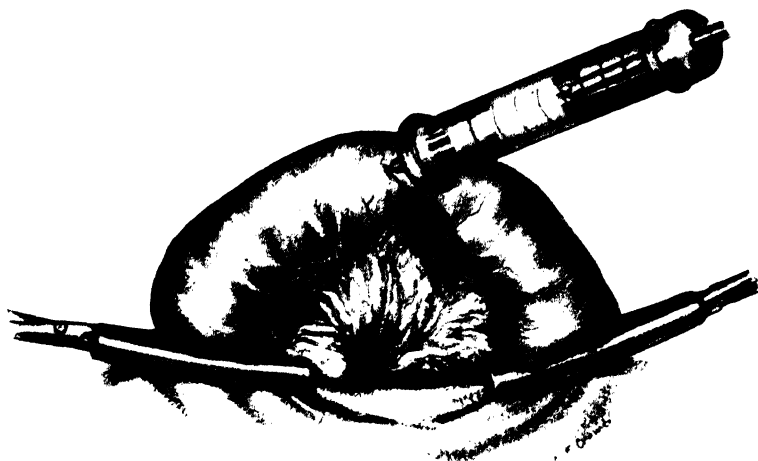
Fig. 213.   Clamps having been applied, the loop is emptied using an aspirating syringe with a needle of wide bore.

urethral catheter is stretched and scored with a scalpel, as shown in Fig. 214. This makes a little groove, in which a No. 000 catgut ligature is fixed. When the catheter is taken off the stretch the suture is imprisoned in the groove, which should be five or six inches from the catheter's eye. The catheter, which has a stopper in its mouth to prevent an unexpected flow, is then buried in the wall of the intestine by Witzel's technique (Fig. 215), employing a suture of No. 000 catgut, starting one and a half inches proximal to the scoring on the catheter. A Bard Parker blade No. 11, or a tenotomy knife, is used for the puncture. Each end of

Fig. 214.   A good method of fixing a stitch to the catheter.   (After Wangensteen.)

the ligature affixed to the catheter is now threaded on a needle and passed through the intestinal wall on either side of the puncture.

By tying the ends the catheter is securely fixed in position. The enfolding stitch is then continued for another one and a half inches. Thus is completed an aseptic enterostomy. If a piece of great omentum is available for reinforcing the suture line, so much the better,
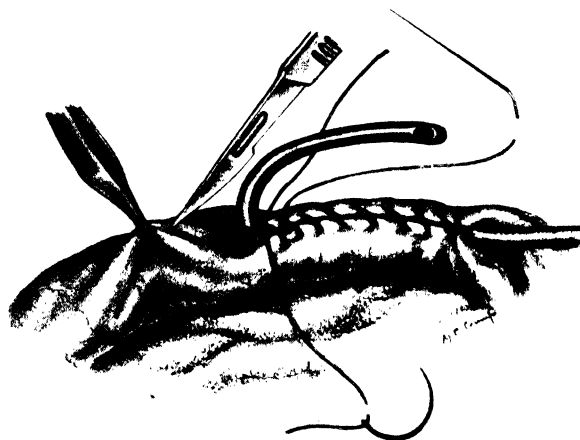
Fig. 215.—Wangensteen's modification of Witzel's operation. The gut is about to be punctured. The end of the catheter is then passed into the intestine.

but we are rarely so favoured, and it is quite unnecessary, and even harmful, to search for it. The loop on which the enterostomy has been performed can be dropped into the peritoneal cavity safely without fear of leakage. When the catheter becomes loose, about the tenth or twelfth day, the tiny peritoneal tunnel closes spontaneously.

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CHAPTER XVI

OBSTRUCTION OF THE SMALL GUT: SPECIAL VARIETIES

OBSTRUCTION BY BANDS AND ADHESIONS

OBSTRUCTION by bands and adhesions requires no detailed consideration. Bands, in particular, constitute one of the most favourable varieties of intestinal obstruction to treat; simple division at once relieves the obstruction. The narrow area which was constricted by the band requires very careful examination, and invagination should be carried out if there is the least suspicion of its viability.

In general, if it is practicable, raw surfaces left by separating adhesions should be covered by omentum, and the stump of a divided band should be invaginated. Attention to these points helps to minimize a recurrence of the trouble at a later date.

INTESTINAL OBSTRUCTION FOLLOWING ACUTE APPENDICITIS

Obstruction following operation for appendicitis rivals general peritonitis as the most lethal complication of the disease. It is to some extent preventable, for its incidence is definitely reduced by adopting the Ochsner-Sherren method in selected cases of acute appendicitis. Preventable, too, since obstruction may be an aftermath of imperfect technique in the matter of removing the appendix or in the insertion and management of a drainage-tube.

Obstruction following acute appendicitis may be divided into two classes:

1. **Obstruction Occurring Remotely after Operation.** With this class of case we are not concerned here, for it properly comes under the category of intestinal obstruction by bands or adhesions (*see above*).

2. **Obstruction Occurring while the Patient is still under Treatment for Acute Appendicitis.**—*Obstruction is most frequent between the sixth and the tenth day after the appendix has been removed.* Realizing this, I make a habit of writing on the notes of a patient in whom intestinal obstruction is a possible development: "Watch for intestinal obstruction, particularly between the sixth and tenth days." Notes of the original operation, particularly those made by the operator himself, are of definite value in picturing the nature of the obstruction. An accurate mental picture of the obstructing agent is the surest help in carrying out appropriate treatment.

Three types of recent post-appendicular obstruction can be recognized, each requiring different treatment.

Type 1.—Recent obstruction by simple band or adhesion may follow any operation for removal of an acutely inflamed appendix. It is, however, more prone to follow a certain type of case, namely : at the original operation the appendix was found occupying a pelvic position in contact with small intestine ; a few bread-and-butter-like adhesions were in the vicinity, but there was little peritonitis. Signs and symptoms are often particularly elusive. The patient, who has been going on perfectly well, suddenly complains of colic, and vomits, usually between the sixth and tenth day after operation. These symptoms in the type of case delineated above are sufficient to warrant opening the abdomen. No form of intestinal obstruction is more urgent, and in no form of intestinal obstruction are physical signs less in evidence.

I was walking through the ward, and noticed a child vomiting who had had an acutely inflamed appendix removed nine days previously and given no cause for anxiety in the meantime. She stated that she had had pain that afternoon. The pulse and temperature were normal, the bowels had been opened that day, and there were no physical signs. I advised operation, and on opening the abdomen found a coil of ballooned intestine angulated by being adherent to the abdominal wall at one point. The acute obstruction was remedied easily.

This favourable result was the outcome of a determined effort to get the next post-appendicular obstruction early. Previously I had missed several cases, partly by heeding the theory of an indiscretion in diet, only to operate too late. The argument is this. If a patient has been convalescing normally until the sixth to tenth day and has given no reason for anxiety in the meantime, and if such a patient has pain and vomits, it is highly probable that he has obstruction. Furthermore, the danger of opening the abdomen of a patient in good condition is infinitely less than that of waiting to confirm the diagnosis in such a fatal condition as post-appendicular obstruction.

Type 2.—This is almost the antithesis of the foregoing. The patient from the very start gives rise to anxiety, for he is distended from peritonitis. The riddle to be answered is : " Are the symptoms due to paralytic ileus or to actual obstruction ? " Almost without exception in the first three days obstructive symptoms under these conditions are due to paralytic ileus. The treatment recommended for paralytic ileus is of a conservative character, and anti-gas-gangrene serum plays a considerable part (*see* PARALYTIC ILEUS, p. 312). The time comes when we can no longer delay ; the plastic peritonitis has evidently given rise to kinks and adhesions at numerous points with which the enfeebled peristaltic waves are unable to compete. The patient is desperately ill. Jejunostomy must be performed forthwith.

Type 3. From our knowledge of the case we picture within the abdomen a length of diseased ileum adherent and impossible to free without a severe operation. Under such circumstances an operation designed to remedy the obstruction too often terminates in an unavoidable resection, for the distended gut is very friable. This type of obstruction is liable to occur after severe pelvic peritonitis. The state of affairs can be visualized by referring to Sampson Handley's illustration of ileus duplex (*Fig.* 216).

Fig. 216. Ileus duplex arising from gangrenous pelvic appendicitis.
(*By kind permission of Mr. Sampson Handley and the 'British Journal of Surgery'.*)

If, on thinking over the case, one has good reason to believe that within the peritoneal cavity there exists a form of obstruction such as has been portrayed above, or, alternatively, if such a condition of compound obstruction has been found on exploratory laparotomy, then, unless the patient's condition is desperate, when jejunostomy or ileostomy offers the only hope, the following form of treatment is indicated.

Through a supra-umbilical mid-line incision a coil of small intestine is found. If neighbouring gut is free from peritonitis and not enormously ballooned, we run the small intestine through our fingers until the commencement of the diseased area is reached. If the great

omentum is well developed, a hole is made in it near its attachment to the transverse colon, and the selected coil is brought through. If the great omentum is poorly developed, this step is omitted. Then, using clamps, lateral anastomosis between the ileum and the transverse colon is performed.

Ileotransverse colostomy in the type of case described would save many lives. The operation is performed through an unscarred area ; the gut is free ; the operation is a 'set' one, and should occupy a definite period of time which can be judged beforehand. It may also be of service in cases properly belonging to *Type* 1 where the obstruction has recurred more than once.

OBSTRUCTION DUE TO MECKEL'S DIVERTICULUM

This embryological structure and its omphalomesenteric duct is not infrequently responsible for the occurrence of intestinal obstruction in an otherwise perfectly healthy, often young, subject. The
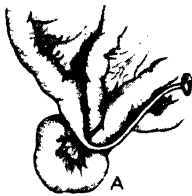
Fig. 217 A. -Loop of intestine passing *under* a Meckelian remnant.
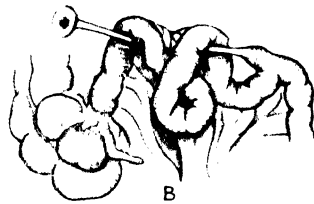
Fig. 217 B. Loop of intestine ensnared *over* a Meckelian remnant.
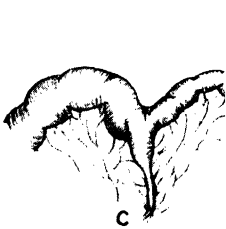
Fig. 217 C. -Kinking due to Meckel's diverticulum.
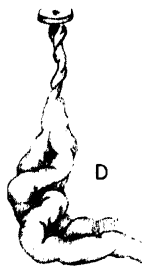
Fig. 217 D. Volvulus due to Meckel's diverticulum.
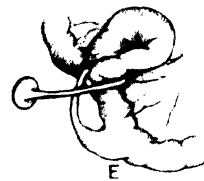
Fig. 217 E. Meckel's diverticulum involving the gut in a knot.

obstruction is produced in a number of ways ; the chief of these may be briefly enumerated as follows : —

1. Its omphalomesenteric duct causes a band under (*Fig.* 217A). or over (*Fig.* 217B), which a loop of intestine becomes snared. This is probably the commonest variety. Suspecting that a band

producing obstruction was an embryological remnant. I sent a piece of it for microscopical scrutiny, which showed clearly its tubular interior. The practical application of this knowledge is that bands should not only be divided, but clamped, ligatured, and, if possible, buried.

2. The end of the diverticulum becomes attached to the mesentery and thereby kinks the ileum (*Fig.* 217c).

3. It may cause volvulus (*Fig.* 217D).

4. Production of knot formation around the gut (*Fig.* 217E).

5. The diverticulum becomes inverted and gives rise to intussusception (*see* p. 256).

There can be no explicit instructions for treating a case of obstruction due to a Meckelian remnant, owing to the great variety of modes by which the obstruction can be produced. Each variety must be treated on its merits. Whenever the condition of the patient allows, the diverticulum should be crushed about a quarter of an inch from its base and removed. The stump being closed, the suture line may be reinforced by a free omental graft.

OBSTRUCTION BY A GALL-STONE

Obturation by gall-stone is a disease of elderly people, and occurs five times more frequently in women.

Grey Turner succinctly sums up the peculiar features of this form of obstruction as follows : Early and copious vomiting which soon becomes intestinal ; incomplete obstruction in the early stages ; marked intermission of symptoms ; rapid maturation of recurrent symptoms ; absence of distension and other physical signs.

In the majority of cases, directly the hand has entered the peritoneum the portion of intestine containing the stone will be encountered. In the exceptional case the search for the point of obstruction is conducted on the usual lines. Once the stone is located, the piece of bowel containing it is gently withdrawn from the abdomen and a clamp applied transversely a little above the point of obstruction. After isolating the loop with towels, an incision is made over the stone in the long axis of the gut on its anti-mesenteric border. Usually the stone

Fig. 218. Gall stone which caused intestinal obstruction in a man of 67. It was found impacted eight inches above the ileocaecal valve, and was successfully removed.

(G. P. B. Huddy's case.)

(*Fig.* 218) can be squeezed out readily. The incision is closed transversely in two layers. The loop is wiped with gauze soaked in hot

saline and returned, and abdomen is closed. It is unnecessary to examine the gall-bladder, and in elderly persons in poor condition this should not be done.

OBSTRUCTION BY A STERCOLITH

Mrs. N. C., aged 38, thirty hours before admission, whilst washing clothes, had sudden abdominal pain. She went straight to bed. The pain became less for a few hours, and then returned as a violent, intermittent colic, coming in spasms every ten minutes. On examination, well-marked visible peristalsis could be seen. Laparotomy was performed. The gut was very distended down to a point where a stone-like body could be felt in the jejunum. Beyond this point the intestine was collapsed. The affected loop having been isolated by towels, a clamp was applied above and below, and a stone measuring 1 in. by 1 in. by $\frac{1}{2}$ in. was removed through a longitudinal incision. The stone was seen to be partially accommodated in a shallow diverticulum in the mesenteric border. The intestine was sewn up transversely in two layers. The gall-bladder was examined and found to be normal, and the abdomen was closed. The stone was sent to the laboratory for examination and was pronounced to be a stercolith. Recovery.

ACUTE OBSTRUCTION BY ANGULATION OF THE INTESTINE

H. A., aged 16, three and a half days before admission, had sudden onset of acute abdominal pain. This passed off in one hour, only to return in the form of severe colic lasting about two to five minutes at a time. He vomited five times on the first day, six on the second, and three on the third. The vomitus was stated to be green at first and later brown. On examination, it was thought that the abdomen was slightly distended, but there were no other physical signs. Even after prolonged watching and ether stimulation of the skin we failed to observe any visible peristalsis. The temperature was 98° and the pulse 100. The patient stated he felt much better, but immediate exploration of the abdomen was advised. On opening the abdomen, enormous loops of small intestine were displayed. The absence of distension was explained by the fact that the obstruction was in the jejunum, and the distension of one-third of the small intestine was compensated by complete collapse of the lower two-thirds. A coil of collapsed intestine was followed up, and after partial evisceration into hot towels the point of

Fig. 219. Obstruction by angulation of the intestine. A loop of intestine has become adherent to a caseating tuberculous gland in the mesentery.

obstruction was found to be a loop of jejunum adherent to a caseating tuberculous gland of the mesentery, thus forming an acute angulation (*Fig. 219*).

The gut was dissected off the gland. A tube was then tied temporarily into the jejunum just above the point of obstruction, and the contents of the bowel were emptied by Holden's method (*see Fig.* 208). Many pints of fæcal fluid were evacuated. The tube was removed, and an omental patch was sutured over the area of adherence. The abdomen was closed and anti-gas-gangrene serum given. The patient made a smooth recovery.

OBSTRUCTION DUE TO VOLVULUS OF THE SMALL INTESTINE

A married woman, aged 37, was admitted on Christmas Day. Except for an indefinite history of indigestion, she had enjoyed normal health until Dec. 21, when she was seized with epigastric pain and vomiting. For four days the pain and vomiting had continued, and there had been absolute constipation. On examination, the abdomen was drum-like. Her general condition was poor. The pulse was 120 and thready, but the patient's mentality was alert. A diagnosis of general peritonitis was made. On opening the abdomen, dark, reddish-brown, evil-smelling fluid escaped, and coils of jet-black small intestine were seen in the pelvis. On further examination, the condition shown in *Fig.* 220 was found. Resection. Ileocæcostomy. Drainage of the peritoneum. The patient died the next day.

An omnibus conductor, aged 24, had acute appendicitis with general peritonitis. The appendix was removed, and the peritoneal cavity was drained. A month later, on the day upon which the patient was to have gone to a convalescent home, he was seized with acute lower abdominal pain, and vomited twice. Within two hours of the onset the abdomen was opened on a diagnosis of intestinal obstruction. A volvulus consisting of about three feet of the lower ileum was found. The gut was dark purple, its mesentery being very acutely twisted. Untwisting was effected easily, and with hot saline the colour of the gut improved. The abdomen was closed. Recovery.

Fig. 220.—Volvulus of the lower ileum. A loop of intestine was the starting-point of the rotation in this case.

ACUTE OBSTRUCTION BY NEOPLASMS OF THE SMALL INTESTINE

New growths of the small intestine are exceedingly rare, and consequently a most exceptional cause of acute intestinal obstruction. I happen to have met with two cases—a carcinoma and a sarcoma. Both were treated by excision and end-to-end anastomosis. In the case of carcinoma of the ileum the growth had perforated, and the patient died of general peritonitis at the end of a week. The case of sarcoma was in a boy of 16 who recovered. Two months later he appeared well, but I was unable to trace him a year later. Probably he had died of secondary deposits.

OBSTRUCTION DUE TO MESENTERIC EMBOLISM AND THROMBOSIS

Occlusion of the superior mesenteric artery or its branches produces a fairly characteristic clinical picture, but because the condition

is rare it is seldom diagnosed correctly. Usually it is evident that the patient has some form of intestinal obstruction; if in addition a cardiac lesion such as mitral stenosis is present, mesenteric embolus should be suspected.

It is of the highest importance to operate at the earliest possible moment; the condition is at least as urgent as a perforated duodenal ulcer.

When the abdomen has been opened, blood-stained fluid escapes. The blue or purplish-black infarcted gut (*Fig.* 221) can hardly be mistaken. If resection is carried out within twelve hours, there is a very fair prospect of recovery. As time goes on the chances of survival become correspondingly slender. It is absolutely contrary to all the principles of surgery gravely to shake one's head and close the abdomen when this condition is found. If the general condition allows, and it usually does, resection must be performed — wide resection — into really healthy gut above and below. Many feet of intestine may have to be removed, but, as pointed out before, it is just as easy to remove six feet as six inches. It is encouraging to remember that as much as 19 feet of small intestine have been resected successfully in this condition. The technique of resection differs from the standard method in only one respect namely, *the infarcted mesentery must also be excised.* A V-shaped resection which includes the damaged mesentery is the best method of procedure. Unless the excision of the mesentery is wide, ligatures will cut through in the sodden semi-gangrenous tissues. Any gangrenous mesentery left behind will almost certainly lead to peritonitis.

Fig. 221 —A segment of intestine for thrombosis of a branch of the mesenteric artery.

An end-to-end anastomosis is the most satisfactory and the quickest method of restoring continuity of the intestine.

OBSTRUCTION CAUSED BY INTERNAL HERNIÆ

Hernia into Retroperitoneal Fossæ.— A hernia into a retro-peritoneal fossa is very exceptional, but a knowledge of these fossæ may prove helpful. In my own practice the very first case of small-gut obstruction I was called upon to treat proved to be a hernia into the fossa ileocæcalis.

Labourer, aged 46. Thirty-six hours before admission had severe abdominal pain and vomiting. For years he had had indigestion and was a very heavy drinker. The temperature was 95 and the pulse 100. The skin was cold and clammy, and the tongue dried and furred. He was a very fat man, which made abdominal examination difficult. There was general rigidity and some distension. On opening the abdomen, a large cyst was felt. A hand passed into the pelvis brought up a lot of jelly which was free in the peritoneal cavity. A hole leading into the sac could be felt to the right of the sacral promontory. The peritoneal sac was slit up on a director, and a mass of blown-up small intestine escaped. After this had been accomplished a piece of mesentery was found to be bleeding furiously, and efforts to stay the hæmorrhage were unavailing. It was decided that the patch of mesentery was gangrenous. Six inches of intestine were there-fore resected, and side-to-side anastomosis was performed. Next day the patient was sitting up in bed and reading the paper. He said he was very hungry but free from pain, but the pulse was 132. It was one of those cases which are 'too well', and which we learn to suspect. He collapsed and died twenty-four hours later. The post-mortem showed a satisfactory anastomosis. I suppose death occurred from delayed shock.

The retroperitoneal fossæ of surgical importance are : —

The *foramen of Winslow* (described fully below).

The *left duodenojejunal fossa* lies to the left side of the fourth part of the duodenum. Its mouth looks to the right. *The inferior mesenteric vein lies in its free border.* (*Figs.* 222, 223.)

The *right duodenojejunal fossa* lies in the mesentery of the very commencement of the jejunum, below the duodenum. Its mouth looks to the right. *The superior mesenteric artery runs in its free edge* (*Fig.* 224).

Fig. 222.—Left duc[...] inferior mesenteric vein (*After Rendle Short.*)

The *fossa ileocæcalis* lies between the meso-appendix and the attachment of the general mesentery. Its mouth looks downwards.

The *ileo-appendicular fossa* lies between the so-called bloodless

fold of Treves and the mesentery of the appendix. Its mouth looks
downwards and to the left.

Fig. 223. Right
paraduodenal hernia
causing acute ob-
struction. (After
Masson and McIndoe.)

The *retrocæcal fossa* lies behind the cæcum. Its mouth looks down.

The *intersigmoid fossa* is situ-
ated in the mesosigmoid. Its mouth
looks downwards.

Treatment. — In dealing with
both the *paraduodenal fossæ* it
behoves us to remember the impor-
tant vessels in their free edge. If
reduction is impossible, it is gener-
ally feasible to cut the neck in an
avascular region. The same pre-
caution should be taken in the case
of the intersigmoid fossa.

The *fossæ round about the cæcum*
are comparatively avascular, and the
neck can be slit as occasion demands.
After the obstruction has been re-
lieved, if time permits, the fossa
should be obliterated by sutures.

Fig. 224. The right duodenojejunal
fossa. The superior mesenteric artery lies
in its free border. (After Rendle Short.)

The foramen of Winslow is bounded in front by the free border of
the gastrohepatic omentum, with the common bile-duct, hepatic artery,
and portal vein between its two layers; behind by the peritoneum

covering the inferior vena cava ; above by the peritoneum on the
caudate lobe of the liver ; and below by the peritoneum covering
the commencement of the duodenum and the hepatic artery. To
cut the neck at any point is therefore totally impracticable. Gentle
traction, combined with very gentle dilatation of the ring with the
little finger, should be tried first. If this fails, the lesser sac should
be opened between the stomach and colon. If reduction is still
impossible from within, several loops of intestine may be emptied
and reduction again attempted. A combination of these manœuvres

Strangulation by a hole in the mesentery. Emptying the
obstructed loop before attempting reduction.

will be sure to produce the desired result. Of 20 recorded laparo-
tomies for intestinal obstruction by herniation through the foramen
of Winslow, 8 lived (Ullman).

Strangulation Caused by a Hole in the Mesentery.— It is most
imprudent to cut the neck of the constricting ring, for not only will
troublesome hæmorrhage occur, but the blood-supply to the overlying
portion of the gut may be endangered. The following method proved
efficient in the solitary instance of this form of obstruction which it
has been my lot to encounter.

The convexity of the obstructed loop was encircled by a purse-string. A large-bore needle connected to an aspirating syringe was used to empty the loop (*Fig.* 225). The purse-string was then tied. The loop having been rendered flaccid, it was found that it could be readily withdrawn.

After the gut has been examined and dealt with as occasion demands, the hole in the mesentery should be closed, or a detached piece of omentum used as a plug.

Other strangulated internal herniæ through holes in the peritoneum require but brief mention. They are very rare, and their treatment follows common-sense lines. They are : —

1. Strangulation through a hole in the transverse mesocolon. Beware the middle colic artery when enlarging the ring.

2. Strangulation through a hole in the broad ligament.

3. Strangulation through a hole in the falciform ligament of the liver. I have encountered a case of this kind.

Strangulated Diaphragmatic Hernia.— This may follow a congenital opening in the diaphragm, or a wound of that structure. In the former variety in particular, it is highly improbable that the condition will be recognized before operation. The hernia, for obvious reasons, is on the left.

Jowers reports the following case in a child, aged 7, where the diagnosis of acute intestinal obstruction, possibly intussusception, had been made.

I opened the abdomen over the left rectus. . . . It was then found that the stomach and duodenum were greatly distended, and the only bowel visible was the descending colon and sigmoid. On raising the stomach a coil of small intestine was seen, and on gentle traction the cæcum and transverse colon came into view, being drawn from an opening in the diaphragm. The ileum was then traced upwards, and collapsed small intestine drawn from the diaphragmatic opening until the duodenum was reached. The child being in poor condition after influenza, and having been some time under the anæsthetic, no attempt was made to close the opening.

The best method of repairing a diaphragmatic hernia is by the thoracic route. In an emergency, unless an irrefutable pre-operative diagnosis has been made, the thoracic route is distinctly contra-indicated. Should the hernia be irreducible, an enlargement of the abdominal incision by a transverse cut to the left, careful packing, the semi-Trendelenburg position, and a headlight should render the point of strangulation in the left cupola visible, and relief can be afforded by a director and a guarded bistoury. The patient should be nursed in the sitting posture in order to minimize recurrence during convalescence. If all goes well, the repair of the hernia can be considered at a later date.

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CHAPTER XVII

INTESTINAL OBSTRUCTION IN THE NEWBORN

INTESTINAL obstruction in the newborn is a subject of its own. The causes of the obstruction are limited. Surgical treatment should be undertaken as soon as the condition is recognized.

Gas and oxygen is the best anæsthesia for these cases, but failing that, a few drops of chloroform (just enough to keep the infant quiet) may be used.

Congenital Intestinal Occlusion. —Congenital intestinal occlusions always occur at the site of an embryological event (Bland-Sutton). Thus we may expect them particularly : (1) In the duodenum (liver and pancreatic buds) ; (2) At the lower end of the ileum (junction of mid- and hind-gut) ; (3) In the rectum (junction of hind-gut and proctodæum). This is borne out in practice. The commonest occlusion is imperforate anus.

IMPERFORATE ANUS

In a few cases there is merely a septum of skin separating the hind-gut from the proctodæum. In others (the majority) the rectum ends blindly well up in the pelvis, an inch or more above the anal dimple. In settling the important question as to which variety is before us, some help can be

Fig. 226. X-ray showing the blind extremity of the gut in a case of imperforate anus. (*Wangensteen and Rice by kind permission of 'Annals of Surgery'.*)

derived from watching and feeling the septum when the child cries. When facilities exist the infant should be X-rayed in the inverted position with a probe or a metal button marking the anal

dimple. In the inverted position gas accumulates in the blind
extremity of the bowel, making it possible to visualize the distance
between the hind-gut and the proctodæum (*Fig.* 226). When it is
impossible to obtain an X-ray of the infant immediately, an aspirating
needle is introduced cautiously through the centre of the anus or
where the anus should be. *It must not be introduced for more than
half an inch.* If meconium is withdrawn, it is certain that the case
is one of the simple variety. All that is necessary is to incise the
septum crucially, dilate with the finger, and unite skin to mucosa
with a few interrupted sutures.

In the more usual type, where the rectum is not accessible, various
operations have been devised to bring the rectum down to the anus,
but they are attended by a heavy mortality. Colostomy is a simple
life-saving procedure. As the patient grows up he can learn to have
one bowel movement a day. Life with a properly fitting colostomy
belt is very tolerable.

Fig. 227. Infant with a left inguinal colostomy performed on the fourth
day after birth, for imperforate anus. The child thrived.

A. P., aged 4 days, had passed no motion since birth. Vomiting was
recurring frequently, and the infant's general condition was feeble. There
was a septum one inch within the anus. No impulse could be felt on crying.
The child was lightly anæsthetized. A hollow needle was introduced for
half an inch, but nothing was withdrawn. Left inguinal colostomy was
performed, using a boiled match-stalk as a spigot. A small rubber tube
performed the function of a colostomy tube. He was discharged two
months later. The colostomy was working satisfactorily and the baby was
gaining weight (*Fig.* 227). Three months later his condition was very
satisfactory.

Congenital Rectovesical Fistula. —This may be present with or
without an imperforate anus. Colostomy should be performed, and
at an early date a second operation to separate bladder from bowel
should be undertaken.

CONGENITAL OCCLUSION OF THE ILEUM

The following case, at which I assisted some years ago, is instructive.

A male infant, aged 4 days, had not passed meconium since birth and had vomited repeatedly. The abdomen was distended. A gum-elastic catheter could be passed freely into the rectum. Laparotomy. The small intestine was enormously dilated, and the dilatation ended abruptly a foot or so from the ileocæcal valve (*Fig.* 228). An attempt was made to divide the occlusion longitudinally and to sew up transversely, but this was difficult on account of the extreme collapse of the gut below, and the friability in the neighbourhood of the septum. The infant died.
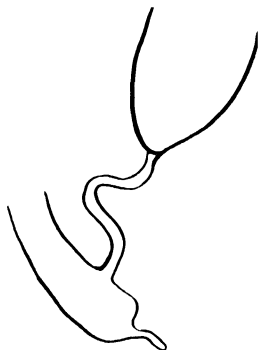
Fig. 228. Congenital occlusion of the ileum.

Perhaps in such a case a lateral anastomosis between the dilated ileum and ascending colon or cæcum would prove an easy and satisfactory measure, providing always that the cæcum and colon were mobile and accessible.

The following method of treating congenital occlusion of the small intestine suggests itself as being practical. A purse-string is inserted in the dilated gut just above the point of occlusion. After stripping the intestinal contents upwards a clamp is applied above this point. A spigot is introduced into the lumen through the area enclosed by the purse-string. Guided by touch the point of the spigot is made to pierce the septum (*Fig.* 229). The spigot is then withdrawn, the purse-string tied, and the abdomen closed.

I tried this principle on an

Fig. 229.—Congenital occlusion of the ileum. A spigot is perforating the septum causing the obstruction.

infant of 8 days, but I made the mistake of introducing the spigot from below upwards. The gut below was only the size of an attenuated tapeworm. The spigot was introduced and the septum perforated easily, but disaster followed the tying
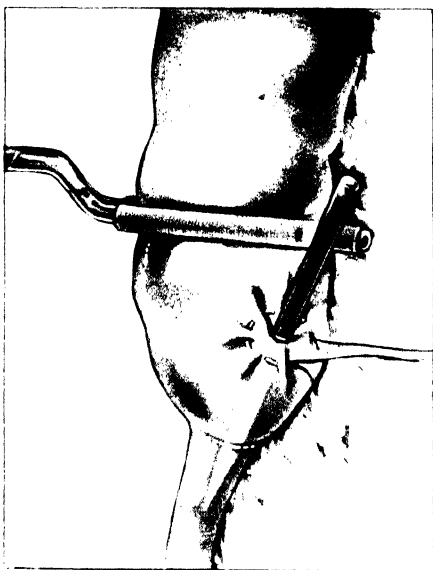
of the purse-string, for it partially cut out, and when reinserted occluded the lumen of the gut to such an extent that enterostomy had to be performed. The catheter was introduced into the dilated gut above, which was the size of an adult piece of small intestine, and I noted that the purse-string held well in the hypertrophied muscular coat. The infant lived for five days and the enterostomy worked freely.

The experience gained by this case convinces me that an operation performed in the manner described above and illustrated in *Fig.* 229 can be brought to a successful conclusion. Morley, in a survey of the literature on this subject, was unable to find a single example of congenital occlusion of the ileum where the infant survived operation more than a few days. More particularly on this account the method which I have described is worthy of a trial.

CONGENITAL DUODENAL OCCLUSION

The infant vomits from birth ; only too often the condition is not thought of until it is too late. Unlike hypertrophic pyloric stenosis of infants, which is seldom very urgent, for the onset is gradual, congenital duodenal occlusion must be treated by operation as soon as the diagnosis is established. The treatment of congenital duodenal occlusion is distinctly urgent. For a reasonably hopeful issue the infant should not be neglected until it is in a dying condition, which, unfortunately, is too often the case.

Saline with glucose infusion should be administered before and during the operation. The best anaesthesia is gas and oxygen. The abdomen is opened by a mid-line or paramedian incision. The duodenum should be examined for a band or some other external obstructing agent. Usually, however, the obstruction lies within in the form of a septum, in which case gastro-enterostomy is probably the best operation.

Duodeno-enterostomy has been practised with occasional success. In cases in which the infant is almost certainly too feeble to stand so formidable an operation as gastro-enterostomy, a catheter might be sewn into the jejunum in order to introduce nourishment, but I am not aware that this measure has ever been successful. Possibly perforation of the septum by a spigot, as described on the previous page, might be applicable in this case.

B. J. W., aged 20 days, had vomited since birth, about one hour after food. The vomit was bile-stained. As might be expected, the infant had become extremely attenuated. The bowels were stated to have moved regularly, the stools being dark brown. Visible peristalsis had been seen by a previous observer. Subcutaneous saline was given. Under gas and oxygen anaesthesia laparotomy was performed, the right rectus being split. The first and second parts of the duodenum were enormously dilated. Posterior gastro-enterostomy was performed. The infant died the next day.

Volvulus Neonatorum.—As a result of the axial rotation of the mesentery the third part of the duodenum becomes acutely kinked, and it is here that the obstruction occurs. The infant is apparently normal at birth, and remains so for a few days. Vomiting then begins, persists, and becomes bile-stained. Early laparotomy is indicated. The volvulus is untwisted, and the cæcum and ascending colon are fixed to the parietal peritoneum in order to prevent a recurrence.

Congenital Strangulated Umbilical Hernia.—The infant may be born with a strangulated umbilical hernia containing either a Meckel's diverticulum or small intestine. Sir L. Barrington-Ward has operated upon two cases of the latter variety. The hernia was found to be filled with an enormously dilated segment of ileum which was everywhere adherent to the sac. The intestine was separated and a radical cure performed. Waugh has recorded a successful resection and anastomosis of intestine in an infant twenty-four hours old with a strangulated umbilical hernia.

Exomphalos.—(It is convenient to deal with this condition here.)

Fig. 230. Exomphalos.

Complete Exomphalos. This condition is [incom]patible with life. Usua[lly the] infant survives a few [hours] only.

Partial Exomphalos. There have been many successf[ul] cases after prompt operation, the infant growing up to be a perfectly healthy adult. Success depends upon operating *within a few hours of birth.*

Partial exomphalos usually presents the following clinical picture. There is a large true umbilical hernia containing coils of small intestine and probably also the cæcum. This is covered, not by skin, but by a thin transparent membrane (amnion) (*Fig.* 230). If untreated, this membrane is soon ruptured by trauma or inflammation, and the case becomes hopeless.

When the sac contains all or a large portion of the liver operation is useless; it will be found impossible to unite the abdominal wall, for the cœlom is too small to contain the viscera.

Operation. An elliptical incision is made at the base of the hernia through normal skin, just beyond its junction with the membrane alluded to. The sac is removed completely and the intestines are bathed in warm saline. The umbilical vein is ligatured flush with the abdominal wall. The abdominal wall is raised by placing two blunt hooks transversely in the extremities of the incision. The intestine can then be reduced within the abdominal cavity. The lips of the wound are approximated by through-and-through silkworm-gut sutures passing through all layers. These sutures should be left in place at least a fortnight.

Using this technique, two out of three cases operated upon by Hutchinson made a complete recovery.

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CHAPTER XVIII

ACUTE INTUSSUSCEPTION

ACUTE INTUSSUSCEPTION OF INFANTS

Operative Treatment.—If the child is collapsed, give saline and glucose per rectum or subcutaneously before commencing the operation.

The Anæsthetic.—For some time I have used spinal anæsthesia in these cases, reserving general anæsthesia for special cases, such as older children in good condition, or when the services of an especially skilled anæsthetist are available. If the child is very collapsed and exhausted, and has lost its power of struggling (a type of case which, thanks to earlier diagnosis, is becoming rare), I avoid spinal anæsthesia and use gas and oxygen. The advantages of spinal anæsthesia to my mind outweigh its disadvantages when operating upon the average case under ordinary emergency conditions.

Technique of Anæsthesia by Spinal Stovaine, and some Advantages of the Method.—With regard to *dosage*, 0·2 c.c. of stovaine in saline is the usual standard dose, but this may vary with the weight of the baby; it should, however, rarely be exceeded under the age of two.

Fig. 231.   Method of holding an infant for puncture.

The lateral position of the patient is adopted for spinal puncture; this position is maintained by an assistant on the left hand side of the table. By passing one arm round the baby's neck and the other under its knees, the assistant can steady the child and maintain flexion of the vertebral column (*Fig.* 231). The operator will find it convenient to be seated. Barker's needles, so generally used for

spinal puncture, are much too large, and are quite unsuitable for infants. A smaller needle should be substituted (*Fig.* 232). The needle is introduced between the second and third lumbar vertebræ.

Observations lead one to believe that in these cases the reduction of intracranial pressure consequent upon the removal of cerebrospinal fluid increases shock considerably. The fluid should, therefore, not be allowed to escape. There is no need to mix the stovaine intimately with the cerebrospinal fluid by repeatedly withdrawing and inserting the piston of the syringe. Indeed, this is a dangerous practice.

The anæsthetic having been introduced, the puncture wound is sealed by collodion in the usual way. Half a centimetre of pituitrin is injected subcutaneously to counteract a fall in blood-pressure, and the operating table may be tilted downwards by the head 20° with the same object in view. I usually ask the nurse to place the
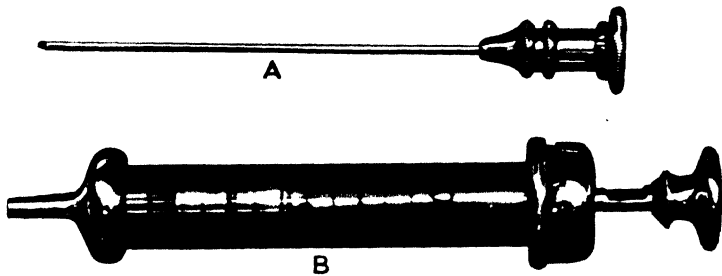
Fig. 232.—Type of lumbar puncture needle used for infants. A. Hollow needle with stylet, referred to in text. B. A 2-c.c. syringe containing 0·2 c.c. of solution. It should be carefully noted that these syringes are variously marked. In some the cubic centimetre is divided into five and in others into ten equal divisions.

corner of a piece of gauze soaked in glycerol in the patient's mouth, and, as often as not, the child sucks the gauze quite happily during the operation, for the stovaine effectually blocks the painful impulses passing from the intestine.

The great advantage which spinal anæsthesia has to offer in these cases is an absolutely relaxed abdominal wall, which greatly facilitates the work of the surgeon and prevents many insults to the plexuses of Auerbach and Meissner.

The necessity of keeping the patient warm during the operation should receive due consideration. A hot-water bottle on the table is quite a good measure, but see that it is properly covered with a blanket, for babies are easily burned.

The Operation.—The aphorism of Jacobson, that the prognosis in intussusception varies inversely with the time that the infant is on

the operating table, applies to reduction under general anæsthesia.
Within reasonable limits, when spinal anæsthesia is being used, there
is no particular necessity for speed.

The abdomen is opened by a right paramedian incision, one-
third being above and two-thirds below the umbilicus. Towels
(abdominal pads soaked in saline do very well—the turkish towels
used for adults are too large) are clipped to the skin edges. The
peritoneum is opened. The fingers seek for the lump in the left iliac
fossa. If it is not there, they pass in order to the splenic flexure, across
to the hepatic, and down the ascending colon. The lump is usually
found without difficulty. In most cases, when stovaine anæsthesia
is used, it is possible to deliver the mass which constitutes the intussus-
ception through the wound with a warm, saline-soaked turkish towel.
This is always possible after the splenic flexure is passed.

Fig. 233.— Method of reducing an intussusception. In attempting to reduce
an intussusception always exert pressure towards the contracted entering
layer.

We will assume that on opening the abdomen the intussusception
has been found in the left iliac fossa. It cannot be delivered by
gentle manipulation, so we commence the reduction intra-abdominally.
The lowest part of the sausage-like mass is squeezed between finger
and thumb (*Fig.* 233) : it will be found to move upwards ; reduction
has commenced. The manipulation is repeated again and again :
each time a little reduction is effected. When the mass has passed
the splenic flexure usually it can be delivered on to the surface easily.
With the intussusception wrapped in a hot towel, the reduction by
squeezing is continued outside the abdomen, where, unhampered by
working in a confined space, the manipulation can be carried out
more easily. The last part of the intussusception is the most difficult
to reduce, but in the majority of instances complete reduction is soon
accomplished ; indeed, the whole process from start to finish can be

carried out in about thirty seconds. It will be noticed that after reduction the cæcum and last coil of intestine (if the intussusception be one of the ileocolic variety) are œdematous and injected. The appendix may look discoloured, but unless it is black it should be left alone. "Any of the devices to shorten the mesentery or anchor the cæcum are examples of misdirected surgical zeal " (Clubbe). The intestine is replaced, and the abdomen closed in layers with tension sutures under the anterior sheath of the rectus abdominis. When the time comes for these to be tied, remember not to tie them too tightly, for a child's tender skin cuts through easily, and this is a
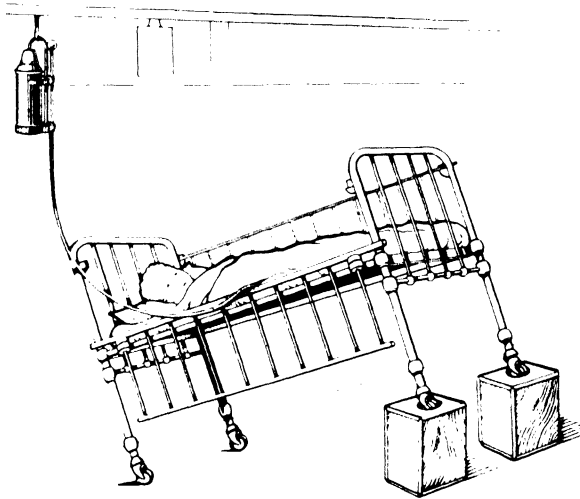
After-treatment of intussusception. The foot of the bed is raised, continual rectal saline instilled by means of Souttar's apparatus.

potent source of an unhealthy wound. The dressing of the abdominal wound requires care. If you try to keep the dressing in place by a many-tailed bandage, in a very short time you will find the dressing on the child's back instead of its abdomen (Clubbe). After the gauze has been applied, an elastoplast dressing is all that is required.

After-treatment.—The child is returned to bed and anti-shock treatment continued. The foot of the bed is raised and continuous rectal saline administered (*Fig. 234*). Nepenthe, min. 1, is given by mouth every three hours for the first nine hours. Sips of cold boiled water can be given frequently. At the third or fourth hour, if the

child is breast-fed and he will suck, breast feeding is started, the mother bending over the prone child, for two minutes on the first occasion, four minutes on the second two hours later, after which proper feeding can be started. If the child is not breast-fed, diluted milk and albumen water is substituted. No purgatives are to be allowed under any consideration. If the bowels have not acted by the end of the second day, a gentle rectal wash-out is given and repeated as necessary.

Stage of Reaction.—About the forty-eighth hour there is often a slight rise in temperature, perhaps to 102° or 103°. This is not of grave significance, and the pyrexia usually abates about the fourth day.

Removal of Stitches.—The stitches should not be removed before the tenth day. If the abdomen was difficult to close (as I have often experienced when operating on these cases under general anæsthesia), the stitches should be left in until the twelfth day. It is a good practice to put on a little pair of 'corsets' before the stitches are taken out. 'Burst abdomen' used to be a common complication of intussusception cases, but is less frequent now the danger of re-opening of the wound is recognized and guarded against.

Reduction of an Intussusception by Rectal Injection.—Rectal injection as a method of treatment of acute intussusception is so uncertain that it is now rightly obsolete. A few surgeons make use of the knowledge that after the patient is anæsthetized ten ounces of saline gravitated into the rectum through a funnel and tube with a catheter on the end from a height of eight feet will reduce almost any intussusception as far as the cæcum. If, after the injection has been made the lump can be felt in the right iliac fossa, the abdomen can be opened by a gridiron incision and the last part of the intussusception delivered and reduced under vision. The method is attractive and may prove useful to those who do not care to use stovaine and have not the services of a skilled anæsthetist. It is common knowledge that the gridiron incision can be closed far more readily than the paramedian.

Recurrence of Acute Intussusception.—After complete reduction by laparotomy recurrence is exceedingly rare soon after operation. Distension and vomiting at this stage are usually caused by damage to the peritoneal coat at the time of the operation. Recurrence, of course, does occur, but it is usually at least two or three months after the original reduction. In a case of my own five months intervened. It is a good measure to anchor the cæcum in the right iliac fossa in recurrent cases unless the condition of the patient is poor.

The Intussusception is Irreducible by the Methods already Described. —Irreducible intussusception is now rare, and is getting rarer. This is

due to the fact that these cases are sent to the surgeon earlier than formerly.

We will assume that the intussusception can be reduced so far, but no farther, and methods of dealing with the situation will be fully discussed.

1. *Forcible Reduction.* - On no account, under any condition, must the entering layer be pulled, but considerable pressure on the apex may be exerted " we may push, but never pull ". This forcible pressure should be exerted evenly for a few minutes in order to lessen venous and lymphatic engorgement. Using gauze to prevent the fingers slipping, an attempt is again made to reduce. Very considerable pressure may sometimes be rewarded. In one of my cases the intussusception, a small tight one, appeared to be absolutely irreducible. The anæsthetist did not think the child could stand resection. One last effort to reduce was therefore made, using both thumbs and all the force that I could muster. There was a faint 'pop', and something shot across the theatre (it was afterwards found to be a piece of blood-clot), but the intussusception was reduced, although the peritoneal coat was lacerated. The child recovered.

Gentleness in operating, especially in childhood, should always be a first consideration, but as long as resection in infants carries such an enormous mortality, forcible reduction will remain an invaluable measure. However, it should be combined with other methods, which will now be described.

2. *Cope's Method.* The little finger insinuated between the entering and ensheathing layers (*Fig.* 235) works round, separating

Fig. 235. — Cope's method of aiding the reduction of a tight intussusception.

the intussuscipiens from the intussusceptum, after which reduction is attempted.

3. *Daw's Method.*—Blunt-nosed forceps, such as sponge-holding forceps, are used to stretch the intussuscipiens, as shown in *Fig.* 236.
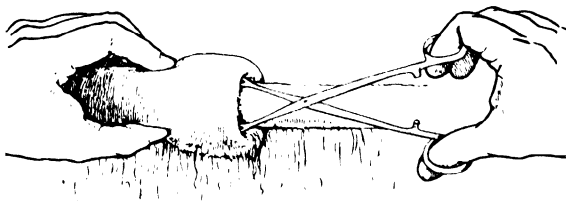
Fig. 236.   Daw's method of stretching the intussuscipiens.

4. *Brown's Method.*—One blade of a pair of Mayo's scissors is introduced on the flat through the constricting band (*Fig.* 237). The band is divided. Reduction is then easily accomplished. The incision, which after reduction will usually be found in the cæcum, is then sewn up.
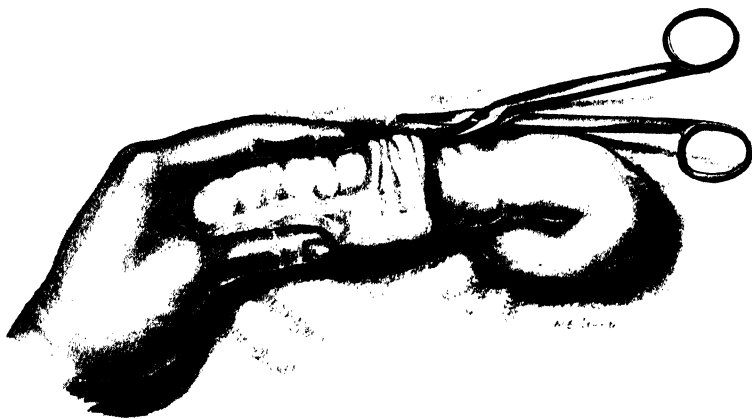
By employing the methods just enumerated the gut *must* be reduced eventually. It will be appreciated that there are occasions for each method. When (2) has failed, (3) may be successful. If methods (2) and (3) fail, (4) is bound to succeed. After it has been found necessary to use (4), the question of viability of the gut may arise, and whilst resection must be performed if the gut is gangrenous, it should be

remembered that Perrin and Lindsay, in their review of 400 cases of intussusception treated at the London Hospital, did not find a single example of survival after resection when the child was below the age of three years. On the other hand, Clubbe, Dowd, Collinson, and others have resected gangrenous intussusception successfully in tiny infants. The chances of survival after resection are very slender indeed.

Summary.—If an intussusception is irreducible by ordinary means, we should have the following mental programme before us, and act on it :—

1. Continuous pressure. Attempt reduction.
2. Cope's method. Attempt reduction.
3. Daw's method. Attempt reduction using forcible pressure.
4. Brown's method Reduction certain if not gangrenous. Sew up hole.
5. Resect only if gangrenous.

Intussusception Protruding from the Anus.—The differential diagnosis between prolapse of the rectum and intussusception may cause considerable confusion, for in both conditions there is a large rosette of inflamed mucosa presenting externally. The diagnosis should be simple if we really think about it. In rectal prolapse the projecting mucosa will be felt to be continuous with the peri-anal skin : whereas in intussusception the finger passes *ad infinitum* into the depths of the sulcus (*Fig.* 238). In this connection I might add that in both my cases the patient was sent in diagnosed as rectal prolapse.

A little girl, aged 4, was brought into hospital. The mother noticed a mass protruding from the anus which had bled since morning. The child looked pale and ill, and on further interrogation it transpired that she had had intermittent colic for twelve hours, and had vomited once. On examination, an intussusception was seen protruding quite three inches from the anal verge. Laparotomy. Ileocolic intussusception reduced. Recovery.

Male, aged 4½. Four hours before admission, whilst coughing, a large red mass protruded at the anus. There was no shock and no pain. The child appeared quite rosy and well. On examination, a mass of mucous membrane could be seen protruding from the anus. The finger, however,

passed *ad infinitum* into the depths of a sulcus. In spite of this I thought
at first that we were dealing with a polypus high in the rectum causing a
local intussusception. Under an anæsthetic it was possible to palpate a
mass in the left iliac fossa continuous with the anal protrusion. Laparotomy.
Colo-colic intussusception reduced. It ended in the right half of the trans-
verse colon. Recovery.

In both cases a particular feature was noted. The intussusception
was readily reducible into the rectum, but it very soon reappeared
through the sphincter. The following plan was therefore adopted.
The intussusception was reduced into the rectum and an assistant
kept it in place with his finger until the abdomen had been opened.
The apex having been grasped from within, reduction was carried out
in the usual manner.

ACUTE INTUSSUSCEPTION IN ADOLESCENCE

The cause of intussusception in adolescent life is so regularly
an inverted Meckel's diverticulum that a precise pre-operative dia-
gnosis often can be made.

ACUTE INTUSSUSCEPTION IN ADULTS

Idiopathic intussusception, so common in infants, is a surgical
curiosity in the adult. Mooro recorded two cases which occurred in
Cairo during the Mohammedan fasting season. Presumably the
abnormal peristalsis caused by the pangs of hunger determined the
invagination. Nearly all acute intussusceptions occurring in adult
life are initiated by some tangible pathological lesion : when the
intussusception is unravelled, an intestinal polypus, a submucosal
lipoma, a somewhat pedunculated carcinoma, an inverted vermiform
appendix, or an inverted Meckel's diverticulum will be found.

The early symptoms and signs of acute intussusception in adolescent
and adult life differ very little, if at all, from those so well known in
the case of infants ; but because the condition is rarer it is seldom
diagnosed until the intussusception is irreducible or even gangrenous.
The mortality of the condition is consequently high.

Mrs. S., aged 47, was admitted as a case of subacute intestinal obstruc-
tion. She gave a history extending over ten days of intermittent abdom-
inal pain accompanied by occasional vomiting. Abdominal examination
revealed nothing definite, although there was a slight suggestive fullness.
As an enema yielded a fair result, she was kept under observation. Two
days later, during the afternoon, I was hastily summoned. She was having
violent abdominal pain and had passed a quantity of blood per rectum.
A rather hard, tender lump could be felt in the hypogastrium. The
rectum was empty, but the examining finger was covered with blood.
Laparotomy. A large ileo-ileal intussusception was delivered. Reduction
was commenced, but soon a point was reached where it would reduce no
further. The intussusception was wrapped in a hot towel and reduction
was again attempted, using some force. Something was felt to give. On

opening the towel it was seen that the external coat had split along its whole length, revealing the steaming, purple-black apex within. Clamps were applied and resection was performed. The distal end of the remaining small intestine was found to be within an inch or two of the ileocæcal valve. The ends of the small intestine were closed and lateral ileocæcostomy was done. Recovery. Five years later the patient wrote to say that she was enjoying perfect health. The bowels moved regularly, and she had had no trouble since her operation.

The specimen is shown in *Fig.* 239. The intussusception was caused by a submucosal lipoma.
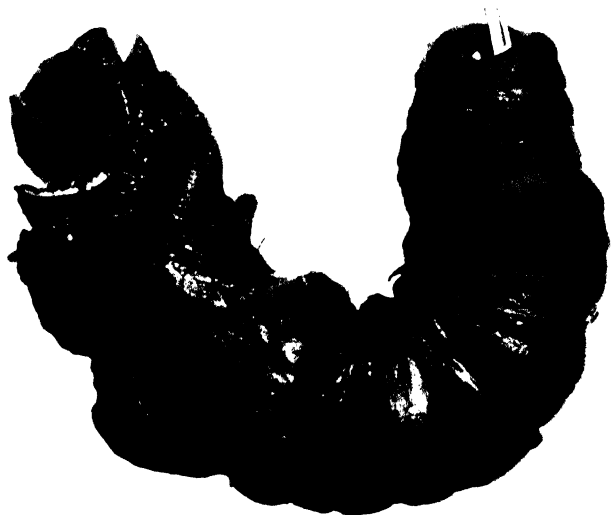
Fig. 239.—A specimen of acute intussusception caused by a submucosal lipoma.

CONDITIONS WHICH ARE SOMETIMES MISTAKEN FOR ACUTE INTUSSUSCEPTION

1. *Purpura with intestinal symptoms.*

A boy of 8 was admitted in a very collapsed condition, with a diagnosis of intussusception. He presented a typical picture of advanced upper-gut obstruction. The eyes were sunken, the tongue was dry and brown, the pulse poor. He was vomiting ceaselessly. The note from his doctor stated that he had passed blood and mucus per rectum. On abdominal examination, there was an ill-defined lump immediately above the umbilicus. On turning the patient on to his side to make a rectal examination, it was noted that the buttocks were covered with purpuric patches, some of which were the size of a two-shilling piece. Purpuric patches were seen on the back and particularly on the lobules of the ears. A number of small spots on the extremities and the abdomen reminded one how easily these spots could be mistaken for flea-bites. The diagnosis of purpura was evident, but it

was thought that there was a concomitant intussusception. The abdomen was opened, and a most astonishing picture was revealed. The jejunum for four feet was the colour of bright-red blood, and on closer examination extravasated blood could be seen beneath the serosa (*Fig. 240*). The whole of this area was heavy with blood. No intussusception or obstruction was found, so the abdomen was closed. The patient was given rectal saline during the night. Calcium lactate was administered later. Recovery.

Intussusception is a well-recognized complication of purpura; a submucosal extravasation of blood probably starts the intussusception

Fig. 240. Sub   in purp

on its course. One should, therefore, always open the abdomen in suspected cases. Occasionally the supposed intussusception will prove to be a large subserosal hæmorrhage, as in the case related above.

Hugh Lett recorded a case of intussusception complicating purpura where a second intussusception occurred four days after one had been reduced, evidently from a fresh patch of hæmorrhage. It follows that after an intussusception complicating purpura has been reduced, all in attendance on the case should watch carefully for

renewed symptoms. A timely reopening of the abdomen may be indicated.

In a case of Fitzwilliams's, blood oozed from the wound continuously after operation, and the patient died. It would be a good practice to have the patient's blood grouped as a precautionary measure in this condition.

2. *Alarming rectal haemorrhage in unsuspected typhoid.*

A patient is seized with abdominal pain accompanied by considerable, if not alarming, bright red rectal haemorrhage—thrice in my experience this syndrome has been the only manifestation of typhoid. In each instance intussusception has been suggested by at least one clinician observing the particular case.

The amount of blood passed in cases of intussusception occurring during adult life is sometimes considerable, consequently the differential diagnosis becomes really difficult. In five out of six examples of proved intussusception occurring in adolescent and adult life which I have treated a lump has been felt in the abdomen at the clinical examination. In the sixth case sigmoidoscopy was rewarded by a unique view of the apex of an intussusception with a carcinoma upon it. Therefore in cases of copious bright red haemorrhage when there is little or no mucus admixed with the blood and no lump to be felt within the abdomen or upon rectal examination, suspect typhoid.

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CHAPTER XIX

STRANGULATED EXTERNAL HERNIA

THERE is seldom any difficulty in the diagnosis, yet over 2000 persons die from strangulated herniæ each year in England and Wales alone. In a condition so supremely remediable by operation, no patient must be abandoned without an active attempt to relieve the obstruction. If there are absolutely no facilities for operation, an uncertain method practised by the semicivilized, viz., thrusting a red-hot poker into the centre of the swelling and trusting that a fæcal fistula will form, is better than hopeless inactivity ; indeed it has saved many lives.

Taxis.—The dangers of taxis are infinitely greater than those of herniotomy. My own view is that taxis is unjustifiable except under the most extenuating circumstances, the only exception being strangulated hernia in infancy (p. 268). As soon as the diagnosis of strangulated hernia has been made, arrangements for operation should be put in motion. In the meantime *postural treatment* can be tried. The foot of the bed is raised about three feet and an injection of morphia is given. In a few cases the hernia reduces itself, in which event, all things being equal, herniotomy should still be advised, but at a convenient time a few days later. This allows thorough preparation and repair by Gallie's fascial graft.

Anæsthesia.—Local anæsthesia for preference in feeble subjects, or spinal anæsthesia, should be employed in all cases of strangulated hernia. Details for local infiltration will be given later.

GENERAL PRINCIPLES IN DEALING WITH THE CONTENTS OF THE SAC

The Fluid in the Sac of a strangulated hernia is teeming with bacteria (*Fig.* 241). Precautions should be taken to ensure that this fluid is
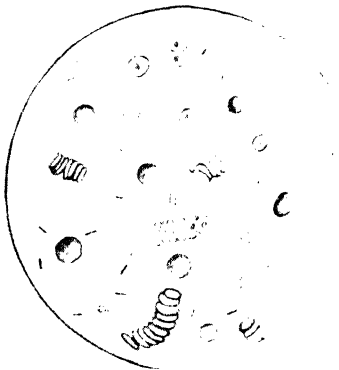
Fig. 241. Smear from the fluid contained in the sac of a strangulated hernia. The fluid is teeming with bacteria.

mopped up thoroughly and does not enter the general peritoneal cavity.

Strangulated Omentum must always be resected. A portion just above the line of strangulation is

chosen, and run through the fingers in order to be quite certain that it is omentum alone that is in the mass about to be removed. Long hæmostats are applied ; as a rule two will suffice, but more will be required when the pedicle is broad. The portion distal to the clamps having been cut off with the scissors, the omentum behind each clamp is transfixed with a needle carrying a ligature, and tied. The omentum is supplied liberally with blood-vessels, and it is imperative to see that hæmostasis is perfect before returning the pedicle into the abdomen.

Strangulated Gut. Immediately the strangulation has been relieved, the gut is delivered into a hot, wet towel. For this purpose turkish towelling, such as is used for clipping to the skin edges, is the best. The towel should be wrung out in really hot saline and not wrung too dry. When there is a real question of doubt as to the viability of the gut, it is justifiable to wait for three, four, or even five minutes, applying repeated towels. Grey, sodden patches on the convexity of the loop, with complete loss of resilience (it has been compared with wet blotting paper), and a fæculent smell in the sac fluid, are conclusive evidence of gangrene. A loop in such a condition should never be returned.

The gut is viable. Inspect the constriction marks (*Fig.* 242) with keen vigilance, especially in strangulated femoral hernia. The proximal constriction has borne the brunt of the obstruction ; when the rest of the gut has resumed its pristine rosy hue, this band may remain pale. Sometimes, if the line is scrutinized, it will be found that it is composed of little more than the serosa. One will be well advised to invaginate this area on the least provocation ; with a well-soaked (pliable) length of intestinal catgut mounted on an eyeless needle the area is pleated, taking care not to narrow the lumen unduly.

The gut is of doubtful viability in circumscribed areas. Patching is indicated. If the great omentum can be found, it is pulled down and the doubtful gut wrapped in it, sutures being placed to maintain the omentum in its desired position.

If there is the slightest tension on the omentum, subsequent intestinal obstruction by band or kink is to be feared. On this account my preference is for the free omental graft. A liberal piece of omentum is resected, and sutured accurately so as to form an overcoat for the whole of the affected loop. I have used this method many times, and never with regret. If the omentum cannot be found, and this is sometimes the case when it is wanted most, recourse will have to be made to invagination or resection. I can imagine the absence of omentum to be the determining factor in deciding for resection.

Finton and Peet have shown experimentally that the free omental graft lives, except in the presence of gross infection. A thin omental

graft remains practically unchanged for at least six months; a fat-laden omentum is less likely to survive.

The gut is gangrenous; the condition of the patient is fairly good. Resection with end-to-end or lateral anastomosis is indicated usually.
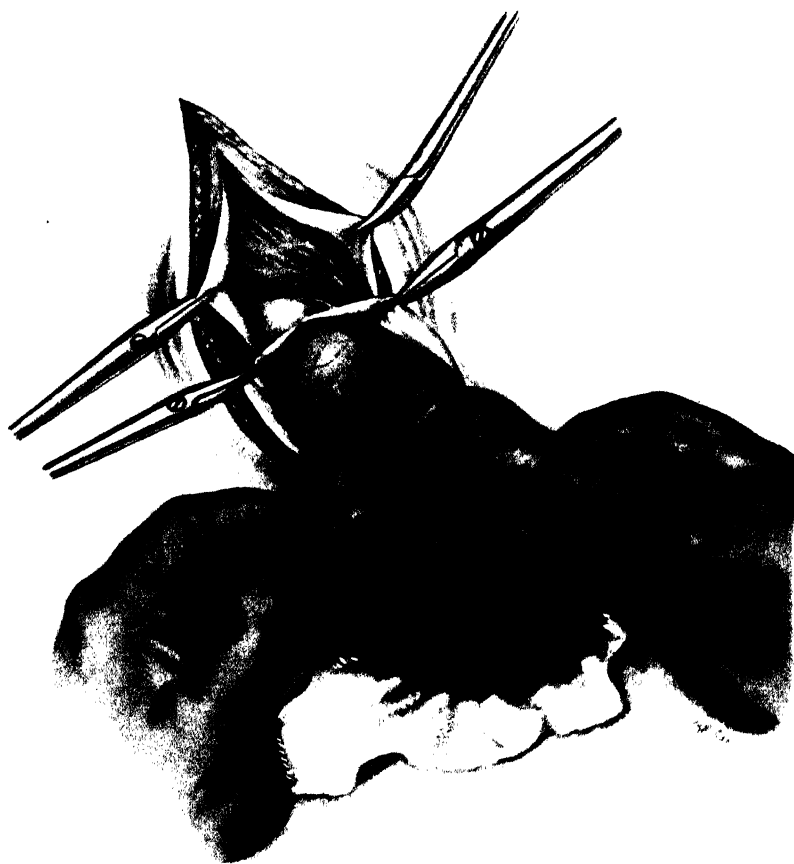
Fig. 242. Strangulated inguinal hernia. The constriction in the neck of the sac has been divided and the imprisoned loop drawn down. Note the constriction marks on the intestine.

Alternatively, exteriorization of the affected loop through a short mid-line incision above the pubis, with repair of the hernia, can be practised. Both procedures are described fully on p. 215, et seq.

The gut is gangrenous; the condition of the patient is grave.
Massed statistics from various clinics prove conclusively that the
mortality of all cases of strangulated hernia where resection and
anastomosis is carried out is between forty and fifty per cent. A
collective research by the Association of Surgeons of Great Britain
and Ireland in 1934 proved this point. It is therefore abundantly
clear that if the patient's condition is grave, resection and anastomosis,
with its immediate or delayed shock, will in all probability rob the
patient of his fighting chance of survival. Exteriorization of the
affected loop through a suprapubic incision (*see* p. 215) is the best
that can be done under the circumstances. In this case no attempt
should be made at an elaborate repair of the hernia. I think it best
to drain the peritoneal cavity via the hernial sac with a piece of
corrugated rubber, and to approximate loosely the muscle layers and
skin about the rubber.

Methods of Dealing with some Rare Contents of the Sac. —

Twisted Ovary and Tube. —Attempt untwisting. If viable, return.
If gangrenous, remove after carefully transfixing the pedicle.

Twisted Testis. Attempt untwisting. Even when this is pos-
sible it will usually be found necessary to perform an orchidectomy
because the cord is too short to place the organ in the scrotum. A
maldescended testis should not be returned into the peritoneal cavity.

Gangrenous Appendix. On four occasions I have found this
condition in a right inguinal or femoral hernia operated upon for
strangulation. The treatment is appendicectomy. If there is pus in
the general peritoneal cavity, drain suprapubically. Close the peri-
toneum and perform herniotomy in the usual way, but put a drain
in the skin wound.

Pus (from General Peritonitis). On examination of the patient,
abdominal distension and a semi-reducible hernia are present. On
opening the hernial sac it is found that its distension is not due to
strangulation, but to an overflow of pus from the general peritoneal
cavity. Place a drainage tube into the sac. If the patient's condi-
tion permits, perform laparotomy. These patients are usually gravely
ill, and it may be wise to limit the operation to suprapubic drainage.

Meckel's Diverticulum. Crush the base of the diverticulum
almost, but not quite, flush with its junction with the ileum. Cut
off the portion distal to the crushing clamp with a cautery, if one is
available. Embed the stump with two rows of sutures ; the technique
of this procedure is referred to on p. 97.

A Diverticulum of the Bladder. —An eagle eye should be kept for
the possibility of a diverticulum of the bladder being in the hernial
sac or in relation to the medial aspect thereof.

Reduction of the Intestine from the Sac into the Abdomen.

Particularly in inguinal herniæ difficulty may be experienced in reducing intestine into the abdomen.

Aids to Reduction.

1. Tilt the table slightly downwards by the head, so that gravity may aid reduction.

2. Put a retractor under the anterior lip of the peritoneal wound and retract upwards.

3. Reduce in orderly sequence, a little at a time, beginning at one end and gently squeezing the intestine between finger and thumb.

4. In extreme distension of the intestine evacuate the contents into a dish through a fine cannula, having inserted, as a preliminary measure, a purse-string which afterwards is used to close the puncture.

During all these manipulations it is of the first importance to keep as much of the intestine as possible under the cover of a hot, moist towel.

STRANGULATED INGUINAL HERNIA

Local Anæsthesia can be employed with satisfaction and great safety. The needle is inserted about one inch internal to the anterior superior iliac spine. The superficial tissues are infiltrated over the inguinal canal and scrotal neck (*Fig.* 243). The incision (*see below*) is made, and the external oblique aponeurosis and the pillars of the ring are defined. The needle is inserted under the external oblique and the injection is made upwards and outwards. With great care the medial aspect of the neck of the sac and the spermatic cord are infiltrated. In tense herniæ the last step can be deferred until the external oblique has been divided, when better mobilization and visualization of the parts to be injected can be made.
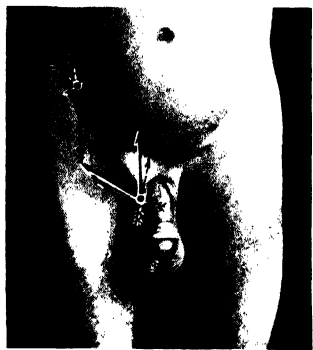
Fig. 243.—Area to be infiltrated with local anæsthetic in the case of strangulated inguinal hernia. (*After Hirschel.*)

Operation. Catheterization is an important part of the preparation of the patient for operation.

The incision is made from the external abdominal ring outwards and slightly upwards. The less the scrotal area is involved in the incision the better, for sebaceous follicles which harbour myriads of organisms are extremely abundant in the skin of the scrotum. Many of the vessels in the subcutis can be caught and divided between ligatures before being cut. Towels are clipped to the wound edges. The incision is deepened until the aponeurosis of the external oblique is seen. Once the

aponeurosis has been identified, the superficial structures can be stripped off it within the limits of the incision, and the anatomy of the region becomes clear. We see the tense sac emerging from the external abdominal ring and passing into the scrotum (*Fig.* 244). The stripping process is continued in the scrotum towards the fundus of the sac. In all but large herniæ it is possible to deliver the sac and the testis out of the scrotum on to the surface. This should be done quite gently. If there is difficulty in delivery, enlarge the incision.

The coverings of the sac are stripped off with dissecting forceps, but there is no need to make a laborious task of this. If they strip

Fig. 244. Strangulated inguinal hernia. The incision has been made and the superficial structures have been divided. The tense sac can be seen emerging through the external abdominal ring.

readily, well and good; if not, leave them alone, except for a small area towards the fundus, which incise layer by layer until the peritoneal coat is entered. Pick up each coat with dissecting forceps and incise it, carefully holding the scalpel almost flat. There is seldom any difficulty in recognizing that the sac has been entered, for fluid runs out and gut or omentum is seen. Enlarge the opening a little, then place gauze over it to allow the escaping fluid to be absorbed while the next step is in progress.

Go to the external abdominal ring. Incise the external oblique, and open up the inguinal canal. Free any bands connecting the neck with the external oblique.

Return to the fundus; with scissors slit up the sac along its anterior aspect, using the finger as a guide (*Fig. 245*). When the actual constriction is encountered (usually in the neighbourhood of the internal abdominal ring), it may be impossible to insinuate the scissors any further, although help may be derived from clipping and strongly elevating the edges of the incision. If there is a tight block to the passage of the scissors, retract the internal oblique and dissect down on to the constriction from without, using the scalpel.

Once the constriction has been divided, the contents can be pulled down and examined (*see Fig. 242*).

A hæmostat should mark each side of the uppermost limit of the incision into the peritoneum, otherwise this may retract under the internal oblique and possibly result in an extraperitoneal reduction of some of the sac contents.

In old-standing cases it may be necessary to free by dissection the intestine or omentum which is adherent to the interior of the sac.

The contents of the hernia having been dealt with according to the principles given on pp. 260-3, repair of the region is undertaken. A moderate-sized hernial sac can be dissected free and, after closing the neck, removed. When dealing with large adherent sacs, a type which is encountered commonly, it seems to be a waste of valuable time to enter upon an extensive dissection. Further, as a result of this dissection, there will be numerous bleeding and oozing points, all of which require hæmostasis, otherwise a scrotal hæmatoma will surely follow.

A far easier plan is to make a 'false neck' (*Fig. 246*). The

Fig. 245. Strangulated inguinal hernia. Slitting up the sac from the fundus and dividing the constricting neck of the sac.

peritoneum over the posterior aspect of the neck is incised, care being taken not to wound the underlying pampiniform plexus. Thus a cuff of peritoneum is turned up and the 'false neck' is formed, which is closed with a purse-string. The distal part of the sac is left alone, or, in certain cases, it is turned inside out and retained in this position by sutures, after the manner of Jaboulay's operation for the radical cure of hydrocele. This is a method which saves much time and has been tested in the crucible of experience.

Fig. 246. Making a false neck when the fundus of the sac is adherent. This procedure saves much time.

Performing a 'Radical Cure'. A 'radical cure' should be performed by the method with which the operator is most familiar. The use of living sutures of fascia—a most excellent method in cases of ordinary hernia—is out of place when strangulation is present. The method I often use in the repair of the inguinal canal is the following one, that of my former master, Jonathan Hutchinson, jun., who made a lifetime study of herniotomy.

A long double thickness of catgut on a curved, round-bodied needle is passed as a mattress suture in the following way : First through the external oblique, then through the conjoint tendon over the cord, through Poupart's ligament, again over the cord, through the conjoint tendon, and out through the external oblique. The free ends are clipped, not tied, for the moment. Two or three sutures are passed

Fig. 247. Repair of the inguinal canal by the method of Jonathan Hutchinson, jun.

according to circumstances. The external oblique is sutured. Finally, the deep mattress sutures are tied. The steps of the operation will be rendered clear by reference to *Fig. 247.*

Strangulated Inguinal Hernia in Infancy.—According to popular teaching, strangulated inguinal herniæ occurring in infancy are always reducible by taxis.   In this instance taxis can be tried, the ' judgement of Solomon ' method (*Fig.* 248) being the most effective.   Nevertheless

some cases are quite irreducible and operation must be resorted to.   I have found this to be the case in seven patients under the age of three years.

The point of obstruction in more than half the cases is at the external abdominal ring. In the remainder, a constriction in the sac itself is the obstructing agent.   The treatment follows the usual lines.   There is no necessity to perform a plastic operation on the inguinal canal.   Removal of the sac is sufficient.

Reduction en Masse.— With a definite history of strangulation of a hernia, reduction by taxis, and a persistence of the symptoms of intestinal obstruction, *reduction en masse* (*Fig.* 249) is a simple diagnosis.   When this history is lacking, the diagnosis becomes difficult ; indeed, we can seldom get further than ' *acute intestinal obstruction—? reduction en masse* '.   The two cases which have come under my notice have been of the latter variety.   The history in each instance was that the patient had worn a truss for years, but he denied that there had been any recent complication in

its management. On examination, an empty inguinal ring was noted and recorded, and as further examination revealed no other cause for the obstruction, the diagnosis of '*acute intestinal obstruction—? reduction en masse* ' was made.

Thus it comes about that laparotomy necessarily is performed to confirm the diagnosis, but whether this route is an ideal one for dealing with the strangulation will be discussed presently.

The notes of the operation on the first case are given below.

A right paramedian incision was made. The intestine was very much ballooned. A collapsed loop was found, and traced down to the internal abdominal ring. In order to give better access to the region, the table was tilted so that the patient was in the semi-Trendelenburg position. After the intestine had been packed off, the constriction was divided by a blunt-pointed bistoury on a director. A loop of intestine was withdrawn. After treatment with hot towels, the gut appeared quite viable and was packed away under the towel. The internal abdominal ring was sewn up with a purse-string suture (it was intended to repair the hernia and remove the sac by the inguinal route at a later date). The abdomen was closed.

The technique used in the operation upon the second case was almost identical.

It is a curious fact that both these patients became very distended and died, one on the fifth and one on the sixth day after operation. A necropsy on the first case showed ileus only ; but in the second case, in addition to the ileus, there was a small quantity of blood-stained fluid which on bacteriological examination was found teeming with streptococci. Although the precaution was taken of packing gauze around the hernial orifice before the constricting band was divided, in order to prevent the fluid from the hernial sac entering the general peritoneal cavity, it would appear quite reasonable to attribute both these deaths to general peritonitis. If this is so, peritonitis almost certainly was due to the entrance of infected fluid from the hernial sac.

To obviate disaster the following method should be employed.

Laparotomy. The diagnosis is confirmed ; a coil is seen entering the internal abdominal ring. Cover the abdominal wound with a towel and put the assistant in charge of the laparotomy wound. Open the inguinal canal and retrieve the sac, if necessary aided by the assistant's hand within the abdomen. Deal with the strangulation as in ordinary strangulated inguinal hernia. Sew up the abdominal wound.

By these measures the infected fluid of the hernial sac will drain externally. An additional advantage of the measure is that herniotomy can be performed.

If speed is essential, the operation must be performed as before, but one should be mindful to nurse the patient in Fowler's position.

Strangulated Sliding Hernia (*Hernia en glissade*).—The posterior wall of the sac in a sliding hernia is formed on the right side by the cæcum and on the left by the pelvic colon (*Fig.* 250). Whilst these organs may be the subject of strangulation, more often it is due to a coil of small intestine which has slipped down into the sac proper.
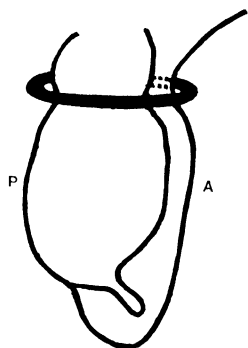
Fig. 250.—Hernia e *glissade*. The posterio of the sac is forme by the cæcum pelvic colon as th may be. P, Posterior wall ; A. Anterior wall.

Hernia *en glissade* presents no special feature as regards the relief of the obstruction, but perplexity may arise as to the manner of dealing with the situation once the obstruction has been relieved. The peritoneum is closed over the anterior wall of the large gut. The whole mass may now be reduced inside the internal abdominal ring, and the inguinal canal obliterated by three mattress sutures passed after the manner of Jonathan Hutchinson, jun.

It might be argued that this is a dangerous practice, and on a par with deliberately performing *reduction en masse*. In practice the method answers admirably. The obstruction has been relieved and the reduction permits the patient to wear a truss, which otherwise would not be possible. These patients are usually old. A truss should be fitted as soon as the scar is sound.

Retrograde Strangulation (*Fig.* 251) may be overlooked. After releasing an imprisoned loop of intestine in a hernial sac the intestine is always drawn downwards a little in order that the gut above the point of obstruction may be inspected. If the gut *above* the point of obstruction is more unhealthy than the gut below, retrograde strangulation may

Fig. 251.—Retrograde strangulation of th

suspected. Under these circumstances, unless *healthy* intestine soon appears, it may be wise to perform laparotomy through a lower paramedian incision in order to make certain that the obstruction has been relieved completely.

STRANGULATED FEMORAL HERNIA

A point worthy of emphasis is the frequent occurrence of a *Richter's hernia (Fig. 252)*. When only a portion of the lumen of the gut is imprisoned the femoral swelling is no bigger than a cherry. In addition, the patient not having complete obstruction continues to have her bowels open or at any rate responds to enemata. Many times I have come across an example of a strangulated Richter's femoral hernia which has been overlooked entirely or treated expectantly until too late.

Fig. 252. Gangrenous Richter's hernia from a case of strangulated femoral hernia.

Taxis as a method of treatment for a strangulated femoral hernia is unjustifiable in a civilized country under modern conditions.
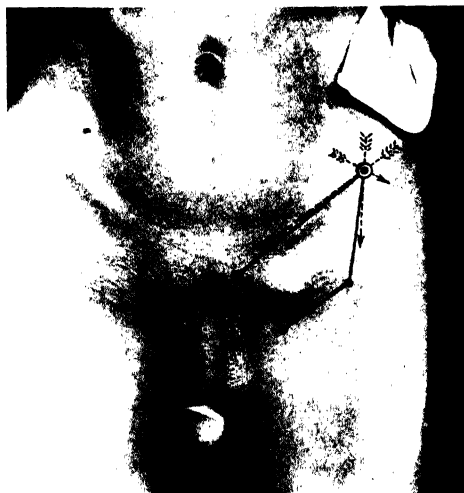
Fig. 253. Area to be infiltrated in the case of a strangulated femoral hernia. (*After Hirschel.*)

The Lower Operation. — The disadvantages of the classical lower operation are sufficiently well-defined to warrant its non-inclusion in this work.

Local Anæsthesia is most effective for use in either of the operations for strangulated femoral hernia about to be described. The area of subcutaneous infiltration is shown in *Fig. 253*. The inguinal canal is anæsthetized in a manner similar to that described in inguinal hernia. In addition the lower skin flap must be retracted and the parts about the sac itself infiltrated, care being taken not to pass the needle into the imprisoned gut.

Operation for Strangulated Femoral Hernia.—In female cases, the nurse who prepares the case is instructed to pass a catheter and leave it *in situ* until the patient is in the theatre. In the male, a catheter is passed in the operating theatre. By observing this rule we obviate the danger of wounding the bladder.

LOTHEISEN'S METHOD (modified).—

Exposing the Sac.—An incision is made half an inch above and parallel to Poupart's ligament (*Fig.* 254). It is rather a long incision, and extends from the pubic spine to within half an inch of the anterior superior iliac spine. The vessels having been ligatured, towels are clipped to the wound edges. The subcutaneous planes are opened up and the external oblique aponeurosis is displayed.

The lower margin of the wound is retracted and the hernial sac enveloped in its coverings is evident. By gauze and forceps dissection, the coverings are shelled off. Attention is directed particularly to cleaning the inner aspect of the neck, with a view to displaying Gimbernat's ligament. After this has been completed satisfactorily, the fundus of the sac is incised and its contents are displayed. This step is desirable for the sole purpose of allowing the blood-stained fluid to drain into a gauze swab. This fluid is swarming with bacteria, and if it is not evacuated it is likely to run into the general peritoneal cavity at a later stage of the operation. Retractors are removed, and the sac, wrapped in a swab, becomes hidden by the lower skin margin.

The Inguinal Stage of the Operation : Opening the General Peritoneal Cavity. The upper edge of the wound is retracted and the external oblique is incised from the external abdominal ring outwards, parallel to, and about three-quarters of an inch above, Poupart's ligament. The inguinal canal is now open. In the male, the spermatic cord is lifted up and held out of the way. A length of gauze threaded

Fig. 254.—Incision for Lotheisen's operation of femoral herniotomy.

beneath the cord makes a convenient retractor. The free edge of the internal oblique, as it sweeps round to mingle in the formation of the conjoint tendon, is identified, and made more obvious by a little blunt dissection. In a small number of cases the deep epigastric

vessels require division between ligatures; in most cases they need not be interfered with. The fascia transversalis is incised, or broken through with dissecting forceps, and the space beneath opened up with the fingers. The peritoneum is in view. It is well to be certain that it *is* the peritoneum, and not the bladder. It is opened with due care, and hæmostats are clipped to its free edge. The interior and the structures passing into the femoral hernia can now be inspected. If it is intestine, the entering and exit coils will be observed. The opening is covered with a towel.

Relieving the Obstruction. The sac is exposed, and with suitable retraction Gimbernat's ligament is sought. Especially in old and emaciated individuals, it is usually possible to break down the obstruction with the finger, but great care is needed lest the friable contents of the sac be injured. If the ligament will not yield, a bistoury guided by a director nicks the ligament in one or two places,* and the finger again attempts to break through, this time with success. Gimbernat's ligament is the obstructing agent in a great proportion of cases, but, as pointed out by Souttar, the obstruction is sometimes in the neck itself. When freeing Gimbernat's ligament fails to relieve the obstruction, I dilate the neck from within with a hæmostat. The beak of the hæmostat is insinuated from within the abdomen down the neck of the sac, hugging the anterior wall, exactly between the entering and exit loops. When it is certain that the hæmostat is correctly placed and the intestine will not be nipped, it is opened. This method has proved quite successful, but it must be pointed out that the hæmostat used has a tapering point, slightly curved on the flat, which happens to be particularly well suited for this manœuvre. Straight, blunt-nose forceps might not be so satisfactory.

Ware's Method of Dividing the Constriction. —A fine eyed-probe is passed from within down the neck of the sac, and by its agency a silk thread is insinuated, the distal extremity of which emerges from the sac below Poupart's ligament. The thread is used after the manner of a Gigli's saw, and the constriction of the neck (or even the partial division of Poupart's ligament in certain stubborn cases) is effected (*Fig.* 255). Sometimes the slightest excursion of the thread will be sufficient to render reduction possible. I have used this method on several occasions, and can speak of it highly. In each instance the silk thread was passed with a blunt-nosed aneurysm needle.

Reduction of the Contents of the Sac. —By gently squeezing the sac below, and at the same time still more gently exerting traction above,

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* The ligament is not divided freely, because of the possibility of wounding an abnormal obturator artery. While this is not a very serious matter when operating by the inguinal route (for the artery can be seen and ligatured), it is better to avoid it.

the coil is reduced into a hot towel, where it awaits the decision as to
its viability which follows the principles laid down on pp. 260 263.
Strangulated omentum is ligatured and removed.

Fig. 255. --Ware's method of dividing the constriction when the constricting
agent is in the neck of the sac itself. A silk thread is passed from above, and the
constriction is sawn through as shown.

Removal of the Sac and Closure of the Peritoneum. — A long-handled
hæmostat is passed down the neck of the sac from the peri-
toneal side and grasps the fundus.
The inverted sac can then be
pulled up above Poupart's
ligament. Occasionally in long-
standing herniæ this step is
not possible until the peritoneal
coat has been freed still further.
The inverted sac is then cut off
flush with the peritoneum. A
purse-string suture, which encircles
both the original opening into the
peritoneum and the mouth of the
sac is inserted, and the peritoneum
is closed. The long ends of the

255. After   of
losed, the fi   ds of t
ay be brought through th
blique by means of an aneury
d then tied. This draws up the
ck of the sac behind that muscl

purse-string. after they have been tied, may be passed through the

overlying muscle and tied again—this draws up the neck of the sac and fixes it under the conjoint tendon (*Fig.* 256).

Plastic Repair of the Abdominal Wall.—The object in view is to bring down the conjoint tendon to the iliopectineal line and thus form a shutter.

The internal oblique, as it joins the conjoint tendon, is retracted, and the peritoneum is pushed up until the iliopectineal line is seen clearly. Running along this bony margin is a reflection backwards of Gimbernat's ligament—the ligament of Astley Cooper. The forefinger of the left hand now seeks the beating external iliac artery as
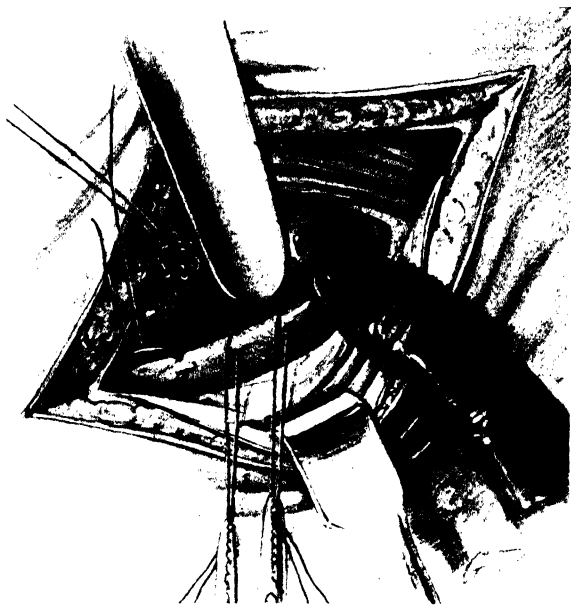
...e of femoral hernia by Lotheisen's method. Passing the fascia overlying the iliopectineal line. The left femoral vein.

it passes beneath Poupart's ligament. After the artery has been identified irrefutably, the forefinger is shifted a finger's breadth to the inner side, and it here rests upon the bone. This finger has the all-important function of protecting the femoral vein, which cannot be defined by palpation. The finger is kept in place until all the deep sutures, presently to be described, are passed.

In order that the iliopectineal line may be clearly visible, good retraction is necessary. A valuable instrument for this purpose is Sargent's retractor; its shining surface also helps to reflect light

into the depths of the wound.   It is held by the assistant in such a way
as to keep back the internal oblique and the peritoneum.   With a
small needle mounted on a holder three interrupted sutures are
passed through the periosteum and Cooper's ligament overlying the
iliopectineal line (*Fig.* 257).   The first of these is near the finger
watching over the femoral vein, and the last near the insertion of
Gimbernat's ligament on to the 'line'.   After each suture has been
placed the needle is removed and the two free ends are clipped together
by a hæmostat.   The diagram (*Fig.* 258) will make this stage of
the operation clear.   The de-tempered, bendable needle is very useful
in passing these deep sutures, and it does not break if bone is
encountered.

     The remainder of the operation is easy.   All retractors are
removed and the guarding finger is taken away.   An empty curved
needle is taken, and by its agency
the free ends of the three sutures are
passed from within outwards through
the conjoint tendon.   These are now
tied, thus approximating the conjoint
tendon to the iliopectineal line.   The
external oblique is sewn up and the
skin edges are approximated.

     HEY GROVES'S OPERATION. — This
excellent operation I reserve for two
types of cases : the very fat patient
with a small hernia ; and the very
ill, frail patient where speed is the
first consideration.   It is an easier
operation to perform than the fore-
going : local anæsthesia can be used
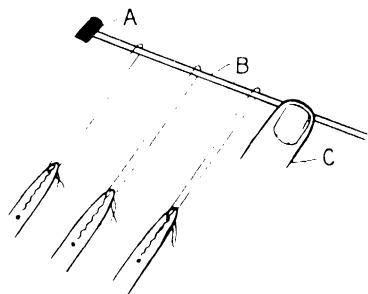
Fig. 258. — Diagram showing the
relationship of the three deep sutures
introduced into the tissues overlying
the iliopectineal line. **A.** Gimbernat's
ligament ; **B.** Iliopectineal and Cooper's
ligament ; **C.** Finger guarding femoral
vein.

satisfactorily, and many, no doubt, will prefer to adopt the operation
as their standard one for all cases.   There is no foundation for the
prevalent conviction that the integrity of Poupart's ligament must
be preserved at all costs.   The end-results of this operation prove
conclusively that the division of the ligament does not weaken the
abdominal wall.

     Technique.   Either a vertical incision over the sac or the same
incision as described for use in Lotheisen's method may be used.   The
sac is exposed and cleaned so that its limitations can be seen clearly.
Poupart's ligament is defined and its insertion into the pubic spine
examined.   The ligament is then cut off the pubic spine close to
the bone (*Fig.* 259).   This is the only somewhat difficult part of the
operation.   Poupart's ligament, as seen when divided, appears to be
a very variable structure.   Some help may be derived from observing

the depth of the ligament from below before making the section. The free end of the ligament is caught in a long hæmostat, which is kept in place until the final stage of the operation. Using the forceps as a tractor, Poupart's ligament is pulled outwards. With a few touches of the scalpel the remaining fibres of Gimbernat's ligament are divided and the neck of the sac is visible. The sac is opened from the fundus upwards, and its contents are dealt with. The sac is removed and the peritoneum closed.

Repair of the Inguino-femoral Region.—With due attention to the femoral vein, sutures are passed through the conjoint tendon and Cooper's ligament. These are now tied and the ends left long. The conjoint tendon is thus sewn down to the iliopectineal line in just the same way as it was in Lotheisen's operation, but the passage of these sutures is much more simple, because Poupart's ligament is not in the way. The forceps holding Poupart's ligament now exert tension towards the pubic spine, but it will be found that the extremity of the ligament will fall short of the spine by about half an inch. The long ends of the sutures referred to just above are passed through the free part of the ligament and again tied. This utilizes Poupart's ligament to reinforce the suture line. All that remains to be done is to close the skin.

Suppurating Gland of Cloquet. There occasions when it is impossible to make a d fer-ential dia sis between a strangulated femoral hernia (omentocele) and an enlarged deep lymphatic gland situated over the femoral canal. If a glandular enlargement is suspected, the

Fig. 250. Hey Groves's operation for strangulated femoral hernia. Poupart's ligament has been removed from the pubic spine and the neck of the sac is displayed.

leg, genitalia, perineum, buttock, and anus are scrutinized for a primary focus. If this search is negative and the neighbouring lymphatic glands are not enlarged, the differential diagnosis becomes insuperably difficult. Under such conditions it is safer to operate. If an enlarged gland is found, it should be removed. If it has broken down, a drainage tube is inserted.

STRANGULATED UMBILICAL HERNIA

Anæsthesia.—It is always problematical if spinal anæsthesia will give anæsthesia sufficiently high for this variety of strangulated hernia. If lumbar puncture is done in a higher space than usual, there is a distinct element of danger. Again, the great obesity of many of the patients with strangulated umbilical hernia makes lumbar puncture a difficult matter. Local anæsthesia after preliminary medication is usually satisfactory, the area around the hernia being blocked (*Fig.* 260). If necessary some evipan can be administered when the peritoneum has been reached. Inhalation anæsthesia is best avoided and is contra-indicated definitely unless the stomach has been washed out.
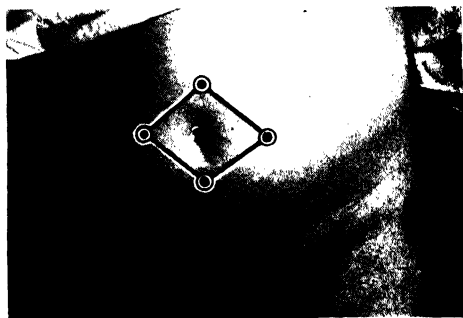
Fig. 260. Area to be infiltrated in the case of a strangulated umbilical hernia.

Operative Treatment : Preparation of the Skin.—On close examination, as often as not, a fold containing evil-smelling sebaceous material will be found. This must be cleansed with ether. When the skin overlying the hernia is eczematous, or otherwise infected, it can be encased by a layer or two of gauze soaked in collodion applied half an hour before the operation. Attention to the skin is very important ; if it is neglected, cellulitis of the abdominal wall, a grave complication, is likely to follow.

The Operation : Mayo's Method.—An elliptical incision is made encircling the hernia with a fairly liberal margin (*Fig.* 261). The incision is deepened through the fat, at first above, then below, then to the left, and finally to the right. During the process the 'island' isolated by the incision is grasped in a towel and retracted at first in one direction and then in another. The object in view is to isolate the neck of the sac. When this has been done the state of affairs is as represented in *Fig.* 262. Retraction is then applied so as to put the neck on the stretch, and with a very gentle stroke of the scalpel, held obliquely, the neck is opened at one point. Once inside, the remaining portion of the circumference of the neck

of the sac can be divided with scalpel or scissors (*Fig.* 263), the
finger acting as a guide to protect the underlying structures. We
now have a large mass, comprising the sac together with the island
of skin and fat, joined to the abdomen by the structures passing
into the sac. This pedicle is
scrutinized. If omentum is
its sole constituent, it may
be ligatured and divided in
sections, thus freeing the mass

Fig. 262. Mayo's opera-
tion for strangulated umbilical
hernia. Diagram showing ' is-
land ' formed after isolation of
the neck of the sac.

Fig. 261. Strangulated umbilical herni
Incision for Mayo's operation.

(*Fig.* 264). If gut is passing
in, the opening into the sac
must be enlarged and the gut
delivered.

*Repair of the Abdominal
Wall.*—The aponeurosis around the inferior lip of the wound must
be cleared of fat. The peritoneum inside the upper lip of the wound

Fig. 263. Strangulated umbilical hernia. Opening the neck of the sac.

is roughened by rubbing with gauze. Mattress sutures are now passed
as shown in *Fig.* 265, and the peritoneum of the upper lip comes to
overlap the aponeurosis of the lower lip, and these having been

treated in the manner just described, they are all the more likely
to adhere. The overlapping upper lip is now sutured down (*Fig.* 266),

Fig. 264.—Island of tissues excised during an operation for strangulated
umbilical hernia.

and all that remains to be done is to close the skin. It is advisable
always to put a tube in the wound for forty-eight hours, for there is
a large dead space which is liable to become infected. By draining
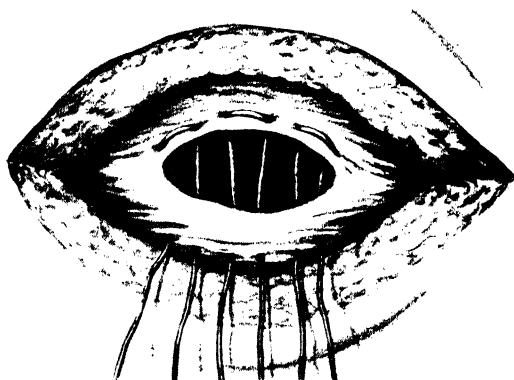
Fig. 265.—Repair of the abdominal wall by Mayo's
sutures are passed.

the subcutis and by the preliminary attention to the folds of
the skin, cellulitis of the abdominal wall (a most fatal preventable

complication) is avoided. I have laboured this point because I saw two cases die from this cause when acting as a house surgeon.
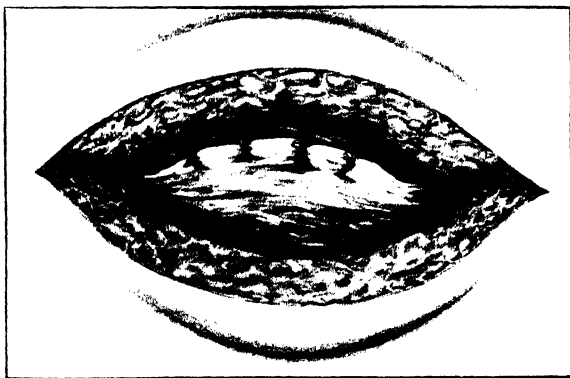
Fig. 266. The mattress sutures are tied, and the resulting overlapping upper lip of fascia is fastened down by interrupted stitches.

STRANGULATED INCISIONAL HERNIA

The mid-line lower abdominal incision is by far the most potent cause of this very serious condition. Strangulation of other incisional herniæ are comparatively rare.

Incarceration of an incisional hernia is a very dangerous and inaccurate diagnosis. The sac almost always contains small intestine, and—probably because the intestine has been entangled in adhesions for a considerable time—the symptoms of acute obstruction are to some extent masked. These patients appear to tolerate the toxæmia of intestinal obstruction in a remarkable manner, whilst gangrene proceeds apace in the sac.

A woman of 58 had a strangulated incisional hernia. Thirty-five years previously Lawson Tait had performed ovariotomy. Five days before I saw her the hernia had become more prominent, and she had vomited but once. She had been treated expectantly. On examination, the skin over the hernia was acutely inflamed and surmounted by a gangrenous patch. At operation the sac was found to contain a coil of black, perforated intestine. The gut was resected and end-to-end anastomosis performed. She died two months later.

Other, almost as striking, examples of the masking of signs of obstruction have been noted in these cases of strangulated incisional herniæ. Wherefore, do not be misled by the lack of indisputable signs of acute intestinal obstruction. Conservatism in these cases usually spells disaster. Operate early.

Operation.—For purposes of operative treatment incisional herniæ may be usefully divided into two classes : (1) Those with a reasonably defined neck ; (2) Large multilocular.

Type 1. —This may be considered as similar to an umbilical hernia, and the transverse encircling incision like that for Mayo's operation (*see* p. 278) may be used with advantage (*Fig.* 267). After the obstruction has been relieved, the abdominal wall can be repaired in a similar manner to the method used in Mayo's operation.
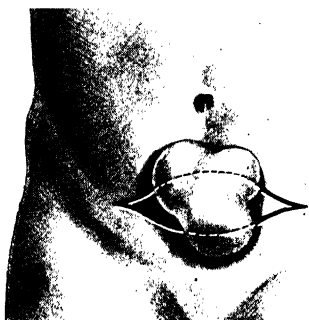
Fig. 267.—Strangulated incisional hernia, *Type* 1. For purposes of treatment it is considered similar to umbilical hernia.
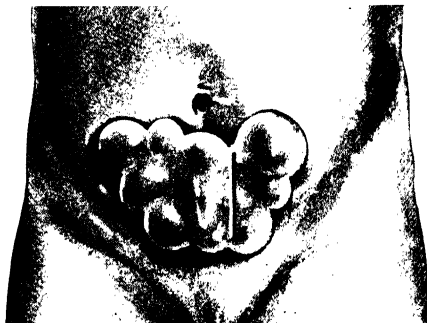
Fig. 268. Strangulated incisional hernia, *Type* 2. The incision is made into that loculus which feels more tense than the remainder.

Type 2.—In large multilocular herniæ, on careful palpation it will usually be found that one loculus is more tense and tender than the remainder. Make a vertical incision over this loculus (*Fig.* 268) with great care, for, as often as not, after the skin has been incised, it will be found that only a veil-like sac separates the scalpel from a tense loop of intestine. In this type of case be content to relieve the obstruction and make no attempt to repair the hernia. In certain cases repair of the abdominal wall may be undertaken at a later date.

STRANGULATED OBTURATOR HERNIA

About 400 cases of obturator hernia have been recorded ; most of these have been cases of strangulation. The symptoms are often obscure, for frequently the strangulation is of the Richter type and constipation is not absolute. This fact accounts for the relatively high mortality of the condition.

In a fair percentage of cases, pain radiating to the knee (Howship-Romberg's sign), due to pressure on the obturator nerve in the obturator canal, is present. If this sign is found in a patient with intestinal obstruction—or, more frequently, partial obstruction –for which no other cause can be found, it is possible to make a correct pre-operative

diagnosis. A fullness in Scarpa's triangle on one side is also a suggestive sign. In about 40 per cent of cases the obturator hernia has been recognized before operation (Bonnet).

Operative Treatment.

The Abdominal Approach : Lower Laparotomy.—A coil of intestine is found passing into the obturator foramen. Have the patient placed in the semi-Trendelenburg position, and carefully pack off coils of intestine with a saline-soaked turkish towel. Take special precautions by suitably packing to see that none of the fluid from the hernial sac enters the general peritoneal cavity. According to the literature, in most of the cases it has been possible to withdraw the gut from the obturator foramen by gentle traction. Should this not be the case, the neck can be enlarged readily with a blunt-pointed bistoury. The hernial orifice should be obliterated whenever possible, for if the sac is left, recurrence is almost inevitable.

The Direct Approach.—A vertical incision is made over the lump to the inner side of the femoral vein. The incision should be fairly long and extend slightly above Poupart's ligament. By dissection the adductor longus is recognized, and retracted inwards. The fibres of the pectineus are divided transversely. The obturator muscle is defined ; the sac may appear above the muscle or through its uppermost fibres.

Disadvantages of the Direct Approach.—(1) The method does not give enough exposure ; (2) The thyroid membrane has large vessels coursing over its deep surface—one of

Fig. 269. Repa * of an obturator hernia from him. The sac is inverted and its neck twisted. * fundus is then *wn to the parietal peritoneum.*

these may be severed when the membrane is nicked ; (3) Once the obstruction has been relieved, the intestine springs back and cannot be examined. In spite of these disadvantages the method has one saving grace—when the sac is opened the infected fluid contained therein drains externally.

The Combined Operation.—P. Bonnet advises a combined operation. If the hernia is recognized beforehand, the direct approach is used and the sac opened, and the operation is then completed by the

abdominal route. If it has not been recognized beforehand, it is more than justifiable to cover the abdominal wound temporarily, and expose and incise the sac in the thigh; then return to the abdomen to complete the operation. Using the combined method, it will be possible in many cases to invert the sac and stitch the inverted sac to the parietal peritoneum—an effective radical cure (*Fig.* 269).

STRANGULATED ¦SCIATIC HERNIA

A. C. Perry recorded a successful case of strangulated sciatic hernia.

A married woman, eighteen weeks pregnant, was admitted with intestinal obstruction. She gave a history of recurrent abdominal pain and vomiting extending over seven days. At operation a collapsed coil of small intestine was traced to the right side of the pelvis. On attempting to bring it up, the intestine tore. Three inches of ileum were resected and end-to-end anastomosis was performed. The hernial sac was found to be situated in the right sciatic notch, above the pyriformis. The patient recovered and the pregnancy went to term.

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CHAPTER XX

THE FEMALE GENERATIVE ORGANS

EXTRA-UTERINE PREGNANCY

ALTHOUGH we are accustomed to speak of a 'ruptured ectopic', tubal abortion is more common than tubal rupture, because the embryo is less often embedded in the isthmus of the tube than in the ampulla. Both conditions cause urgent symptoms, but of the two a tubal rupture is the more serious.

Operative Treatment of Ruptured Ectopic Gestation.— Ruptured ectopic is a most satisfactory condition to treat. Although the patient may be pulseless and absolutely blanched, there is hope. Even when the condition is so advanced that anæsthesia is unnecessary, it is possible to save the patient's life. In desperate cases blood transfusion is an auxiliary measure which should be arranged for as soon as possible. In the meantime, intravenous gum saline will be indicated. Autotransfusion (p. 288) can be practised at the time of the operation ; indeed a ruptured ectopic gestation is the condition *par excellence* for autotransfusion.

Remember to inquire if the bladder is empty. If there is any doubt, pass a catheter.

The Trendelenburg Position.— If the diagnosis of ruptured ectopic is even suspected, arrangements for the adoption of Trendelenburg's position should be made *before commencing the operation*. Most modern operating tables are provided with shoulder rests. These should be placed in position. Strapping the legs to the table is quite a satisfactory method for maintaining the patient in a moderate degree of Trendelenburg's position. A slight tilt of the table is all that is required. It is unnecessary and harmful to place the patient in the high Trendelenburg position, which invites the settling of blood and blood-clot in the upper abdomen.

Saline Infusion.— In collapsed patients it is a good practice, especially for the single-handed surgeon, to commence the operation by inserting the needles of a subcutaneous saline apparatus into the breast or to insert the cannula of a continuous intravenous saline apparatus into a vein. The patient can then receive saline throughout the operation.

The Incision.— In most cases a correct diagnosis can be made. Under such circumstances the right paramedian incision is used. In

rarer instances the diagnosis may be confused with appendicitis. If Battle's incision has been employed, it may be prolonged down to the pubic bone, when excellent access to the pelvis will be obtained. If a gridiron incision has been used, and, by palpation, it is certain that it is a *right* ruptured ectopic, prolong the incision downwards to the pubic bone by detaching the internal oblique from the rectus sheath (*see* pp. 44, 45). If by inserting a finger into the pelvis soft adhesions tell that it is the left tube which is the seat of the trouble, close the gridiron incision and make a right or left paramedian. In doubtful cases the diagnosis is usually proclaimed as soon as the abdominal muscles have been retracted, for the blood can be seen through the peritoneum as a slate-blue discoloration.
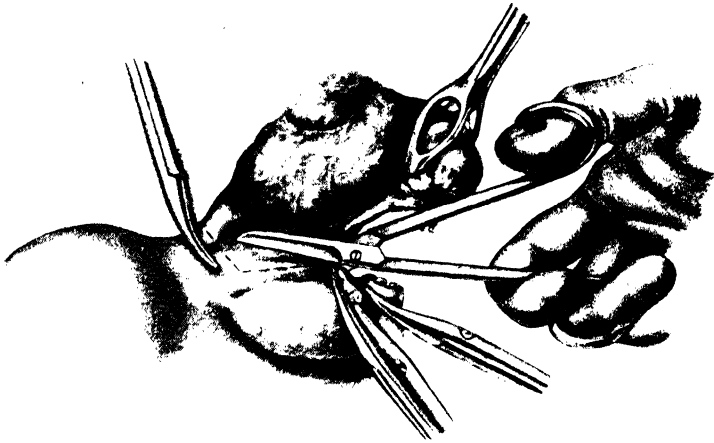
Fig. 270. Ruptured ectopic gestation. Excision of the Fallopian tube. Morrant Baker's forceps, encircling but not crushing the tube, should be noted.

Protection of the Skin Edges.—Within the peritoneum is a mass of blood and blood-clot, an excellent medium for bacterial growth. Asepsis should be as perfect as possible. To this end, the moment or two expended in clipping towels to the skin edges is time well spent. In this connection it may be mentioned that appendicectomy should not be performed, even if the appendix is available.

The Operation.—The fingers are passed into the pelvis and the fundus of the uterus is felt. Soft adhesions and swelling of the tube will bespeak the side which is involved. No time is wasted in evacuating blood and blood-clot. As soon as the diagnosis is confirmed the table is tilted. When the desired position has been obtained, the intestines

are tucked back towards the upper abdomen and packed off with a
turkish towel well soaked in saline, so that it is heavy and does not
readily become displaced. The fundus of the uterus having been
grasped by the fingers of the left hand, it is tilted up towards the
wound. A long hæmostat is made to grasp the tube near its junction
with the uterus. Very gentle traction can be applied by this, and
the rest of the tube is freed. A pair of Morrant Baker forceps now

Fig. 271. —Ruptured ectopic gestation. Embryo and its coverings found
in the blood-clot removed.

encircles the tube near the ostium. The broad ligament is identified,
and, using long hæmostats, the tube, by clipping then cutting, is freed
and removed (*Fig.* 270). There now remain two or three hæmostats
gripping sections of the broad ligament, and one placed more medially
containing the stump of the tube. Each section is transfixed with
a needle carrying a long ligature which has been tried and tested.
The ligatures are tied on either side of the forceps, and are left long

until we are satisfied that hæmostasis is perfect, when they are cut.
If the condition of the patient is good, the stump of the tube is buried
by bringing over neighbouring peritoneum. Attention is then turned
to cleansing the peritoneum. Clots are scooped out with the hand.
A soup ladle, or a large spoon, is a useful instrument to remove liquid
blood, especially if autotransfusion* is contemplated. Instructions
are now given to tilt the table slowly back to the horizontal position.
The towel protecting the intestine is removed, and more blood gravi-
tates into the pelvis and iliac fossæ ; this is mopped up. Unless the
condition of the patient demands all the speed possible, the mopping
up of blood and blood-clot is done systematically. The abdomen
is then closed. The embryo is usually to be found in the removed
blood-clot (*Fig.* 271).

The patient, wrapped up well, and with hot-
water bottles between the blankets, is returned to
bed. Usually the pulse soon becomes stronger,
and gradually she is propped up until the full
Fowler's position is attained. There is often a
sharp rise of temperature about the second day.
This should not be a source of undue anxiety,
for the pyrexia is often transitory, and due,
not to infection, but to the absorption of fibrin
ferment.

Sometimes, during convalescence, a cast of
the uterus is expelled (*Fig.* 272).

Dangers and Difficulties.— The hazards and
difficulties of the operation are fortunately few :

Fig. 272. - Com
plete decidual cast
extruded per vaginam
on the fifth day after
an operation for rup
tured ectopic gestation

1. The rupture may be near the uterus. When
it is the isthmus which has given way, the tech-
nique should be modified somewhat. The
fundus of the uterus is grasped with tissue-
holding forceps, which act as a tractor and serve to steady the
organ. A small wedge of uterine tissue, which includes the origin
of the tube, is removed. Mattress sutures are used to close the
uterine wall.

2. Bilateral tubal pregnancy has occurred a sufficient number of
times to warrant the routine examination of *both* tubes.

3. Adherence to neighbouring structures. In one of my cases,
when adhesions had been separated, there was a raw bleeding area
on the pelvic colon, presumably where the chorionic villi had taken
root. The eroded area was covered in by a free omental graft.

* Autotransfusion should not be used as a routine measure but only when
the patient is desperately anæmic. The method is not without danger. (*Hejek.*)

Rare cases have been reported in which perforation of the colon, rectum, or bladder has occurred from this cause, and such a possibility should be remembered.

Tubal Pregnancy without Rupture or Abortion.—It is very exceptional and fortunate for a case of tubal pregnancy to come to operation before rupture or abortion has occurred. *Fig. 273* shows such a specimen. The diagnosis of acute appendicitis had been made. There was, however, one atypical feature in the history— *the pain began in the right side.* The tube was very mobile, and salpingectomy was carried out through a gridiron incision.
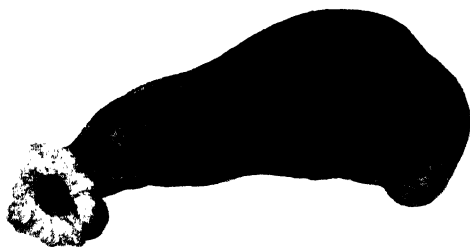
Tubal pregnancy without rupture. ...sis of acute appendicitis was made.

OVARIAN CYSTS

Ruptured Lutein Cyst.—Ruptured lutein cyst, or apoplectic ovary, is rather uncommon. If the condition could be diagnosed with certainty, surgical treatment would probably be unnecessary in the majority of instances, although in one of my cases the haemorrhage was considerable, and comparable in every way to a tubal abortion. Usually, however, the haemorrhage is slight, and it is only the impossibility of distinguishing with certainty this condition from appendicitis which brings these cases to operation.

When, in a young woman, the diagnosis of appendicitis is probable but not certain, and we have decided to operate, it is a good practice to open the abdomen by Battle's incision, which allows a thorough inspection of the pelvic viscera. I have found a ruptured lutein cyst on 10 occasions. All the patients were between 14 and 25 years of age, and only one was married, and she very recently. The most interesting example was as follows:—

Miss C., aged 19, had had a dull pain in her right side for a week. This had not prevented her from going to work until forty-eight hours before admission, when the pain became more severe. She complained of nausea, but had not vomited. Her periods were quite regular, and the last had finished eight days previously. The temperature was normal and the pulse 96. On examination, there was acute tenderness in the right iliac fossa and hyperaesthesia of the skin. Per rectum there was fullness in the pouch of Douglas. On opening the abdomen some blood was found. As the ovary was being delivered, a round, red ball, the size of a walnut, looking like blood-clot contained in a thin membrane, slipped out of a

ruptured cyst of the ovary (*Fig.* 274). This was followed by a little dark, altered blood, and considerable fresh arterial hæmorrhage. The cavity of the cyst was obliterated by a running suture, which at once controlled the hæmorrhage. About two ounces of blood-clot were swabbed out of the pouch of Douglas. The appendix was removed, and the abdominal wound closed without drainage.
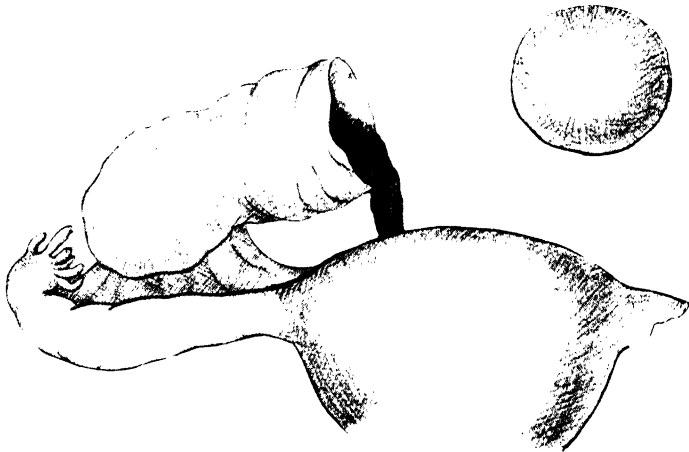
Fig. 274. –Ruptured lutein cyst. From a sketch made by the author after operation upon the case cited in the text.

All that is necessary is to suture the cyst wall and mop up the blood. A running suture applied near the junction of the cyst wall and the surface of the ovary will be found to act quite well, but the suture must not be tied too tightly. The tissue near the edges of the rupture is always very friable ; hence the base is selected for the introduction of the suture.

It is quite unnecessary to remove the ovary.

Acute Complications of Ovarian Cysts.

Torsion of the Ovarian Pedicle.—The following example will serve to typify this rather common emergency.

A married woman, aged 40, whilst on the lavatory, experienced intense abdominal pain and vomited. The pain continued up to the time she was examined in hospital, eight hours later. She had vomited three times in all during the hours which preceded her admission. The pulse was 100 and the temperature subnormal. A large, rounded, very tender swelling could be felt rising out of the pelvis. Laparotomy was performed, and an ovarian cyst the size of a football, and almost black in colour, presented. The pedicle had rotated several times. The pedicle was doubly ligatured and the cyst removed.

The same precautions regarding the arrangements for Trende-lenburg's position, and of making sure that the bladder is empty, as

have been described in the previous section, should be taken. The abdomen is usually opened by a *right paramedian incision*, but in cases where the swelling is palpable on the left, the left paramedian

size of a cocoanut ren   d fr
The pregnancy went t

incision should be chosen. On opening the peritoneum some blood-stained fluid may escape. The table is now tilted to bring the pelvic organs into view. The cyst (*Fig.* 275) is delivered through the wound. If necessary, the incision may be enlarged in order to facilitate the delivery of the intact cyst. In exceptionally large cysts it may be advisable to empty the cyst with a trocar, but as a rule this is

Fig. 276. Dividing the ovarian pedicle between hæmostats.

unnecessary. The pedicle is traced down to its origin and two long hæmostats are applied. Between these the pedicle is divided (*Fig.* 276). The base of the pedicle is now transfixed with a stout ligature

previously tested (*Fig.* 277). This is tied. It is a wise precaution
to apply two ligatures to the base of the pedicle in case one should
break or slip. The stump should be covered by peritoneum on every
possible occasion.

. -Ligature of an ovarian pedicle. It is a wise precaution to apply
two ligatures before removing the forceps.

Cysts of the fimbriated extremity and the hydatid of Morgagni
present no special features. An example is illustrated in *Fig.* 278.
Providing the cyst is removed before peritonitis from gangrene of
the cyst has advanced, the prognosis in these cases is excellent.

Fig. 278.—Torsion of the Fallopian tube, with a cyst of
extremity. The ovary, which is also seen in the specimen, was bh
rhagic, and was therefore also removed. From a girl aged 21.

Suppurating Ovarian Cyst.—

Mrs. S., aged 57, had had vague abdominal pain for fourteen days.
Three days previously the pain became much worse, and was situated
mainly in the lower abdomen. On examination, the pulse and temperature
were normal. There was general abdominal rigidity and shifting dullness.
In the pelvis a large swelling could be felt. A diagnosis of (?) twisted
ovarian cyst was made. On opening the abdomen frankly purulent fluid
escaped. A large suppurating right ovarian cyst was removed, and the
peritoneum drained suprapubically. Recovery.

On cutting into the specimen the interior of the cyst was filled with typical pseudomucin. One portion of the cyst wall was thicker than the remainder, and this area was sparsely honeycombed with purulent material. The appendix was examined at operation and found to be normal.

Rupture of a Dermoid Ovarian Cyst. —

A woman of 48 was admitted with general peritonitis. Her symptoms had commenced very suddenly five hours previously. The whole abdomen was intensely rigid, and shifting dullness could be elicited. On a diagnosis of perforated gastric ulcer, the upper abdomen was explored, but no perforation in stomach, duodenum, or gall-bladder was found. The peritoneal cavity below the umbilicus contained gruel-like fluid. A hand passed down towards the pelvis discovered a semi-collapsed ovarian cyst. The upper abdominal incision was closed and a left lower paramedian made, and through this ovariotomy was performed. The cyst, which was a dermoid of the left ovary, had a ragged tear through which its contents were escaping. The peritoneal cavity was drained suprapubically, and convalescence was uneventful.

Rupture of a Malignant Ovarian Cyst. —

A spinster of 35 was admitted in a collapsed condition. There was a history of two attacks of pain lasting about four hours during the two preceding months. The present (third attack) commenced three days previously, and the pain was located mainly in the left iliac fossa. On examination, the pulse-rate was 134 and the temperature 99·9°. The abdomen was enormously distended, dull in both iliac fossae and the hypogastrium, resonant around and above the umbilicus. There was no shifting dullness. Rectal examination was negative. A diagnosis of appendix abscess spreading to the left iliac fossa and leaking into the general peritoneal cavity was made, but we did not feel very confident about it. A leucocyte count was therefore done, and returned 17,200. The abdomen was opened by Battle's incision, and on incising the peritoneum quarts of jelly-like material exuded. A pailful of this material flowed out over the towels into the bucket. On passing a hand into the pelvis the collapsed shell of an ovarian cyst was felt at once. This was delivered, and its pedicle divided between forceps. The pedicle was a very thick one, so it was sewn with a running suture, instead of ligaturing it. Suprapubic drainage. The patient's condition improved almost as soon as the abdomen was opened, and convalescence was smooth. Four months later she returned with a large swelling of the abdomen and much emaciation. Laparotomy showed multiple secondary deposits of carcinoma over the whole of the peritoneum. Death one month later.

Occasionally when operating for acute appendicitis an ovarian cyst is found. As a rule it is advisable to remove the cyst as well as the appendix. An interesting example of bilateral chocolate cysts came to my notice in this way.

Miss K. L., aged 27, had a typical history and signs of appendicitis of twenty-four hours' duration. On opening the abdomen an acutely inflamed retrocaecal appendix was found and removed. The appendix was later found to contain pus. There was some dark, chocolate-coloured fluid

in the abdomen, and on passing a hand into the pelvis two large ovarian cysts were discovered. The right cyst was removed. With the object of conserving some ovarian tissue, instead of ovariotomy the left cyst was incised, and black, tarry fluid evacuated. The cyst wall was then turned inside out after the manner of Jaboulay's operation for hydrocele. One year later the patient was in good health and menstruating regularly.

Slipping of the Ligature of an Ovarian Pedicle. Rutherford Morison writes: " No pedicle should slip if it is properly tied. After several hundred ovariotomies the following case has been my first personal experience of such an accident. I removed a large, broad-ligament, papillomatous ovarian cyst at 12.30 p.m. The operation presented no difficulty. At 6 p.m. the same day Mr. Willan found the patient pallid, pulseless, and complaining of noises in the head, and mistiness of vision. The abdomen was dull in both flanks. He made a diagnosis of slipped pedicle with intraperitoneal haemorrhage, and took her to the operating theatre at once. On opening the wound the abdomen was found to contain abundant clots and fluid blood, but the circulation was now so weak that some oozing only was observable. The pedicle was re-sutured and intravenous transfusion carried out. Recovery ensued."

ACUTE SALPINGITIS

It is best to adopt a conservative attitude towards acute salpingitis and pelvic peritonitis resulting therefrom. The patient is placed in Fowler's position, given water only by mouth for four days, and in the great majority of cases resolution occurs. In a few cases a collection of pus forms in the pelvis. This is drained, preferably per vaginam (posterior colpotomy see p. 295).

The differential diagnosis between salpingitis and other varieties of pelvic peritonitis, notably pelvic appendicitis, is often difficult, sometimes insuperably so. Should the abdomen be opened and an acute salpingitis found, mop up the purulent exudate, preserving if possible a specimen of the fluid for bacteriological examination.* The appendix may be removed if thought desirable, but excision of acutely inflamed tubes is not indicated.

From mis-diagnosis or uncertainty I have opened the abdomen and found salpingitis on several occasions. In the majority the purulent fluid was mopped up, the appendix removed, and the wound closed completely. In the minority the amount of fluid in the pelvis was considerable and frankly purulent ; a suprapubic drainage tube was therefore inserted. In 3 cases only a distended pyosalpinx was found, and, as the disease appeared to be confined to the tube, salpingectomy was performed. All the cases recovered.

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* In gonococcal peritonitis the report on the fluid is nearly always returned ' sterile '.

POSTERIOR COLPOTOMY

Posterior colpotomy is a good method of draining a local collection of pus in the pouch of Douglas, particularly when the abscess is connected with disease of the internal genitalia.

Preliminary Preparation.—The vulva is shaved and the bladder is emptied by a catheter.
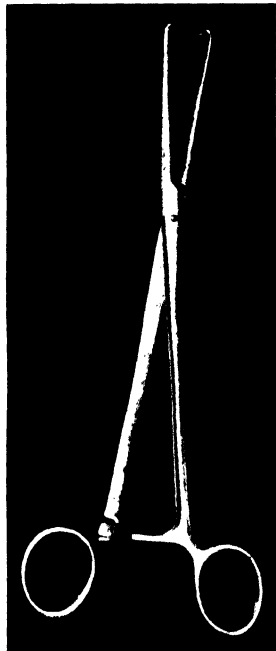
FIG. 280. A volsellum.

After being anæsthetized, the patient is placed in the lithotomy position. The vulva is washed thoroughly with ether soap and warm water. The interior of the vagina, including the fornices, is scrubbed with gauze over the fingers, using a soapy solution. This is followed by an ample douche of 1 1000 perchloride of mercury.

The Operation. A posterior vaginal speculum is placed in position. Auvard's self-retaining weighted speculum (*Fig.* 279) is very convenient, and a headlight is an advantage. The posterior lip of the cervix is grasped in a volsellum (*Fig.* 280) and pulled downwards and slightly forwards. If the posterior fornix is bulging and

œdematous—in other words, if the abscess is pointing—a pair of sinus forceps may be used. The forceps, with blades closed, are passed into the most prominent part of the swelling. The blades are then opened, and pus pours out.

If the abscess is not pointing, but it is thought advisable to drain by this route, pull the cervix downwards and slightly forwards with the volsellum, and make a transverse incision through the vaginal mucosa

at the junction of the posterior fornix and the cervix (*Fig.* 281). This exposes the peritoneum. Proceed now with long curved scissors. As soon as the peritoneum comes clearly into view, pinch it up in a long hæmostat, and make a transverse nick in it. The finger is passed through this and the incision enlarged if necessary. When an abscess has been opened into the vagina, a drainage tube is passed up into the abscess cavity.

NECROBIOSIS OF A UTERINE FIBROID GIVING RISE TO PERITONITIS

Mrs. M. C., aged 39, was twenty weeks pregnant. On the night before admission she was awakened at 3 a.m. with abdominal pain which had continued for twenty hours. The pulse was 96 and the temperature normal. The uterus extended to the umbilicus, and to the right of it a very hard tender lump could be felt. A diagnosis of ovarian cyst, ? appendix abscess, was made. She was placed in Fowler's position and an hourly pulse and
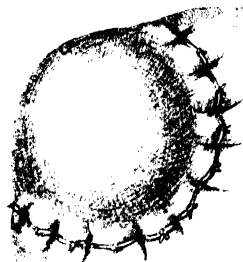
Fig. 282. N
fibroid. Sutures
the base of the

temperature chart kept. During the night the pain became intense, the pulse rose steadily to 120, and she vomited. At 4.30 a.m. it was decided to operate. On opening the peritoneum some seropurulent fluid escaped. A subserous, non-pedunculated fibroid the size of a g..... , and alm.... black in colour, came into view. We tried to recognize the fishy odour said to accompany necrobiosis, but we were unable to detect it. After

Fig. 283. Enucleating the

packing off with gauze, the fibroid was surrounded by a ring of sutures passed through the muscular wall (Fig. 282). These were tied. An incision was then made through the peritoneum at the base of the fibroid. By gauze dissection, aided by the handle of the scalpel and here and there by the knife, the fibroid was enucleated (Fig. 283). It did not come away very easily, and smart hæmorrhage occurred in spite of the ring of sutures. This was quelled with turpentine on a swab. The gap was then closed by a number of mattress sutures introduced on a blunt needle (Fig. 284). Finally, the peritoneum was brought over the suture line and the abdomen closed without drainage. On bisecting the specimen acute degeneration was evident, and at one spot pus was seen. Two days later the patient aborted, after which she made a good recovery.

Using the same technique I removed a necrobiotic fibroid from a woman 6 months pregnant. In this instance the pregnancy was not disturbed.

HYSTERECTOMY

The indications for hysterectomy in emergency surgery are few—namely, for injury, and very occasionally in ectopic gestation when the rupture is situated at the junction of the tube with the uterus. In the latter case a wedge-shaped resection of the tube from the uterus, with subsequent repair of the uterine wall by mattress sutures, usually meets the case.

OVARIAN ART.

ROUND LIGAMENT

UTERINE ART.

URETER
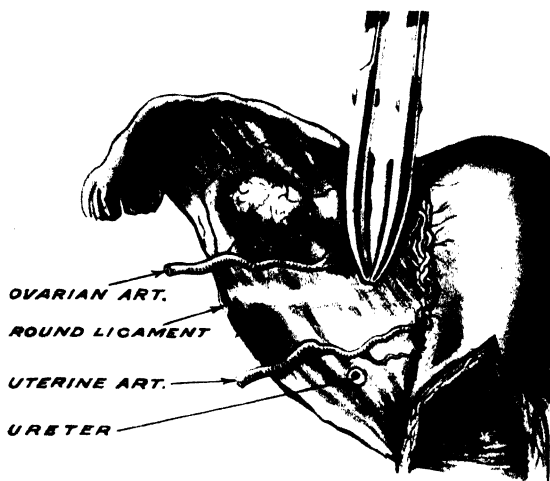
Fig. 285. —The blood-supply of the uterus with especial reference to hysterectomy. (After Bland-Sutton.) (See text.)

In performing urgent subtotal hysterectomy, there is, as a rule, no need to excise the ovary, and usually the tubes may remain.

Trendelenburg's position is essential. It is a mistake to be cramped for room ; the incision should be ample. Packing off the intestines is carried out in the same manner as indicated in the section on ruptured ectopic gestation (pp. 286, 287).

1. The fundus of the uterus is grasped with a volsellum. Referring to *Fig.* 285, we see that the ovarian artery lies some distance beneath the tube. Haemostats are applied to the broad ligament close to the uterus, and include the tube and as much mesometrium as possible ; in this way the ovarian artery is included in the bite. With scissors, the tissue is divided between the haemostats

2. The round ligaments are divided between hæmostats.

3. The broad ligament is still further divided. This area is avascular.

4. With the uterus retracted to the opposite side, the layers of the broad ligament are opened up with the finger, and the uterine arteries are exposed at the sides of the uterus near the cervix.

5. Taking care not to injure the bladder, a flap of peritoneum is reflected off the anterior wall of the uterus near its junction with the neck.

Fig. 286. Subtotal hysterectomy. The broad ligaments have been divided, the uterine arteries clamped, and the cervix is being divided. (After Berkeley and Bonney.)

6. The uterine arteries can be seen coursing up the uterine wall, or, if not seen, their pulsations can be felt. Pressure forceps are applied to them on each side.

7. A posterior flap may be fashioned, but usually this is not necessary. The operator pulls the uterus towards him and amputates the organ just above the point where the uterine vessels are clamped (Fig. 286).

8. Each of the forceps contains an important vessel. With long, well-tested ligatures on a needle mounted in a holder, the tissue included in the forceps is transfixed and ligatured. Oozing from the stump is controlled by mattress sutures.

9. After the field has been mopped and hæmostasis is satisfactory, the peritoneum is drawn together with interrupted or continuous sutures over the cervical stump.

HÆMATOCOLPOS

The recurrent attacks of pain have many times been mistaken for appendicitis. If there is a hæmatometra in addition the resulting pelvic swelling can add to the difficulties of diagnosis. Once the condition is recognized treatment is of the simplest character. An incision large enough to admit the index finger is made in the centre of the hymen, and the retained menses, in the form of tarry fluid, pour out.

HÆMATOMETRA OF ONE HALF OF A BICORNUATE UTERUS

I was called to see an Italian girl aged 20. She was having agonizing attacks of abdominal pain precisely similar to left renal colic with one exception the pain began in the groin and passed to the loin. For four or five years there had been similar attacks, but they were getting more acute. She had been in three hospitals for renal investigation, with negative findings. Two or three hours later cystoscopy was performed. Both kidneys proved to be functioning satisfactorily. A pelvic examination revealed an indefinite tender swelling on the left side of the pelvis. On opening the abdomen this was found to be due to what appeared to be a fibroid on the left side of the fundus of the uterus. The mass, which was the size of an orange, was resected from the uterus; the resulting cavity was closed with mattress sutures. On bisecting the specimen it was found to contain a closed cavity, filled with tarry blood under great pressure. Recovery. The patient has remained well and menstruates regularly.

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CHAPTER XXI

THE RECTUM AND ANUS

INJURIES TO THE RECTUM

INJURIES to the rectum are, for the most part, due to the patient sitting forcibly upon a somewhat spiked object.

These injuries are liable to be overlooked. W. G. Spencer describes the case of a man who stepped backwards off a wall two feet high and hit the handle of an upturned barrow. There was some blood about the anus, but on examination by the resident at hospital nothing serious was thought to be the matter. Later, when general peritonitis had supervened, a rupture of the rectum into the peritoneal cavity was found, but it was too late to save the patient's life.

W. G. Spencer's Second Case. -

A boy of 7, whilst playing, fell against the leg of an upturned chair. His mother found blood upon his trousers, and sent for the doctor. Within six hours of the injury signs of general peritonitis became evident. There was no external injury, but a rectal examination showed a rent in the anterior wall of the rectum. On opening the abdomen blood-stained fluid escaped. The peritoneum was found to be inflamed. The urine contained blood, but the bladder proved to be watertight. The abdomen was closed around a drainage tube passing to the rectovesical pouch. On dividing the sphincter ani backwards to the tip of the coccyx the rent in the rectum was exposed fully. It was situated on the anterior wall, just above the internal sphincter. The margins were ragged and infiltrated with blood. Exploration with fingers and probe did not reveal any actual perforation. All wounds healed without complication.

Injuries to the rectum may (1) be limited to the mucosa, (2) pass more deeply and later give rise to pelvic cellulitis, (3) penetrate the peritoneum or bladder, or both. (*See also* COMPRESSED-AIR RUPTURE OF THE LARGE INTESTINE, p. 191.)

Treatment.— If the rectum has been damaged, the patient must be anaesthetized and examined under the anaesthetic. The anterior wall should receive especial attention. The examining finger will detect a laceration but may fail to perceive a puncture. Inspection can be carried out with the aid of a speculum and a headlight. A probe, used gently, will tell the depth of the wound. If the mucosa is involved alone, the rectum is douched with a mild antiseptic, after which a tube wrapped in gauze and soaked in glycerol, such as is used after the excision of haemorrhoids, is placed in position. More

extensive wounds require prolonged and certain drainage, which can only be effected *by dividing the sphincters backwards towards the coccyx*. This, in addition, gives splendid access to the interior of the rectum for further exploration.

When the Peritoneum has been Penetrated.—This may be evident by signs of peritonitis, or, in early cases, may be discovered in the examination of the rectum. Laparotomy is indicated without delay, the left paramedian incision being ideal for the purpose. If the case is an early one, it may be possible to suture the perforation, after carefully packing off the intestines and adopting Trendelenburg's position. After closing the perforation the peritoneum should be drained. In all cases where there is an extension tear of the rectal wall a temporary left inguinal colostomy should be regarded as a necessity.

It is a mistake to pack wounds of the rectum with gauze. It only prevents healing and tends to encourage sepsis. A tube up to the site of the laceration is all that is required. Some gauze wrapped around the tube and soaked in glycerol or paraffin is not open to this objection, and does good by keeping an oily film between the wound and the lumen of the rectum. If gross sepsis can be avoided, the rectal wall heals readily.

When the Bladder has been Penetrated. Rectovesical fistula, faecal cystitis, and its attendant evils, are prone to follow if the condition is not treated.

A straightforward recent communication between the bladder and the rectum is treated by suprapubic cystostomy and transvesical suture of the perforation. The bladder is drained suprapubically and a tube passing to the laceration is left in the rectum. Very gentle bladder washes are commenced on the following day.

FOREIGN BODY IN THE RECTUM

By accident, depravity, or imbecility, foreign bodies become lodged in the rectum beyond the recall of the patient. The variety of these foreign bodies is hardly less remarkable than the ingenuity displayed by surgeons in removing them. Fenwick delivered a turnip by way of the anus, using obstetric forceps. Leber, finding that a stick could not be withdrawn, inserted a gimlet into its lower end. With the additional leverage thus attained, the stick, twelve inches in length, was extracted successfully. Diggins, being confronted with a man who had in his rectum a tumbler, the bottom of which was nine inches from the anus, stuffed the interior of the glass with gauze dipped in plaster-of-Paris paste. The last strip was sufficiently long to hang outside. In half-an-hour's time the plaster had set and Diggins successfully pulled out the glass. This

ingenious method, which was originally suggested and practised by Le Fort, should be tried in every instance of a wide-mouthed receptacle looking downwards.

When the Foreign Body cannot be Delivered from Below. — If considerable difficulty is encountered in getting hold of the object in the rectum, the abdomen should be opened on the left side in a manner similar to Battle's incision. This gives easy access to the pelvic colon. The surgeon, with a hand in the abdomen, can as a rule squeeze the object downwards to the assistant, who awaits its accessibility for extraction through the anus. In the only instance in which I performed this type of operation (for a gall-stone), I gained the impression that it is preferable to resort to laparotomy at the first sign of real difficulty. Prolonged anæsthesia, the possible laceration of the rectal wall, and the uncertainty of ultimate success are dangers attendant on undue reluctance to open the abdomen.

Even when the abdomen has been opened it may be impossible to pass the object downwards—a very rare event.

P. R. Hawe's Case. —

A man, aged 55, who was admitted to the Northern Hospital, Liverpool, had suffered from a rectal prolapse for many years, which recently had become difficult to reduce. He was advised by his friends to try to reduce it by pressure with the bottom of a half-pound jam jar, and by some extraordinary mischance forced the jar up past the tuber ischii into the rectum. He attempted to remove the jar himself, but failed, and it was not until three days later that he visited his doctor. Even with anæsthesia and the use of all the available forceps and retractors it was found impossible to extract the jar. Laparotomy was therefore performed, and an attempt was made to pass the jar downwards, but without success; it could not be manœuvred past the ischial plane. After completely isolating the area with packs, a longitudinal incision was made in the pelvic colon, and through this the jar was extracted. The opening was closed transversely, and a corrugated rubber strip passed down to the suture line. As the anus and rectum were in an extremely infected and œdematous condition, a temporary colostomy was performed. The colostomy was opened forty-eight hours later, and the rectum and lower colon were treated with lavage from above. In three weeks time the rectal condition had returned to normal, and the colostomy was closed successfully.

ISCHIORECTAL ABSCESS

We should not wait until an ischiorectal abscess points; it must be excised at the earliest possible moment. A brawny induration about the base of the ischiorectal fossa is sufficient indication that an incision is necessary. There will be little or no redness of the skin at this stage. Nearly all fistulæ-in-ano are the direct result of waiting for fluctuation. A small incision is poor treatment and also invites the formation of a fistula-in-ano. A heinous offence is to follow up a small incision by endeavouring to open the abscess

by Hilton's method. I saw a case at necropsy where this had been
done, and evidently the forceps had penetrated through the apex
of the fossa, resulting in widespread retroperitoneal cellulitis.

Fig. 287. The incision for ischiorectal abscess.

With the patient in the lithotomy position, a crucial incision
is made over the base of the fossa (*Fig.* 287). The incision is enlarged

*Fig. 288. The four flaps resulting from the above incision are dissected
free and removed as shown.*

with scissors until it extends from the top to the bottom of the abscess
and from side to side. Care is taken not to touch the external

sphincter. The triangular flaps are lifted up with dissecting forceps and each is excised along its attached base (*Fig.* 288). When the medial flaps are excised care is needed to avoid injuring the sphincter muscle. The skin is excised to a point just within the anal canal. The abscess is explored with the finger and any septa broken down. Ligatures are avoided as far as possible. When the abscess is bilateral both sides should be opened up by the technique described, together with the communicating track. In the rare event of the case being a pelvirectal abscess, and pus is found coming from above the levator ani, the opening in the apex of the ischiorectal fossa is enlarged with the finger and a drainage tube inserted. Otherwise no drainage tube is used. In neglected cases of ischiorectal abscesses bubbles of gas are noted when the abscess is opened. The same treatment as outlined above is employed. Often a very large incision is necessary. Anti-gas-gangrene serum can be administered with advantage.

After-treatment.—A flat, moist dressing soaked in flavine, eusol, or a saturated solution of magnesium sulphate, is applied to the wound. The cavity is not packed. Hip baths can be commenced on the following day in most cases. No plugging is used in the after-treatment. In order to expedite healing when the granulations have filled the cavity, skin grafting is of value (W. B. Gabriel).

HÆMORRHOIDS

Prolapsed and Strangulated Hæmorrhoids.- A typical history is somewhat as follows : The patient is admitted with a large mass of prolapsed internal hæmorrhoids, blue, and often bleeding. He states that for a long time the piles have come down after defæcation, but, until the day previous, he was able to get them back.

A hot bath is given and the mass is washed gently, after which the patient goes to bed. The foot of the bed is raised on blocks, and $\frac{1}{4}$ gr. to $\frac{1}{3}$ gr. of morphia is given subcutaneously. The patient is told to lie on his back or side, whichever he finds more comfortable. A large quantity of gauze soaked in normal saline is applied to the anus, covered with jaconet, and kept in position by an ample four-tailed bandage. The dressing is changed every four hours. Some adrenalin may be added to the saline in cases where œdema is a marked feature. Next morning the patient is quite comfortable. An examination of the local conditions, as a rule, shows but little change. The gauze soaks are persevered with, and liquid paraffin is ordered by mouth. There is no need to be concerned with the movement of the bowels for the first three days. If they have not acted by the fourth day, a gentle glycerin enema through a catheter is ordered, and if much pain follows, morphia is given again. Gradually the mass gets smaller, and by the end of a week the piles are barely

visible. In stubborn cases it may be fourteen days before resolution occurs.

Then, after suitable preparation, removal of the hæmorrhoids is undertaken. So satisfactory is the treatment of hæmorrhoids by injection that there are but few cases in which operation is indicated. However, one feels that after hæmorrhoids have once strangulated they are better removed. This may be only a pious belief, for in a few debilitated subjects in which an anæsthetic was contra-indicated, I have treated even this class of hæmorrhoid by injection with very satisfactory results.

Stretching the Sphincter. Stretching the sphincter and replacement of the hæmorrhoids is a most excellent method of starting treatment *providing the case comes under observation during the first few*

Fig. 289. Recent rectal prolapse with strangulation. The history of this patient was that three hours before admission the hæmorrhoids had come down and could not be replaced. In these *recent* cases dilatation of the sphincter and reposition of the hæmorrhoids is a satisfactory measure.

hours (*Fig.* 289). After the sphincter has been stretched and the prolapsed hæmorrhoids replaced, the buttocks should be strapped together with broad adhesive plaster (*Fig.* 290) for twenty-four or forty-eight hours. If the hæmorrhoids have been 'out' more than twelve hours, in addition to being more or less strangulated they are no doubt inflamed. Uniformly excellent results have attended the very large number of cases treated by the conservative measures outlined above. If the reader feels that the sphincter should be stretched in every case, there is no harm done, but it seems a pity to subject the patient to an anæsthetic when we know that another anæsthetic for removal of the hæmorrhoids will be necessary in about ten days' time.

To stretch the sphincter under an anæsthetic in selected cases may hasten resolution, but to go further, and remove the hæmorrhoids

in the acute attack, is the essence of bad surgery. Œdematous hæmorrhoids are friable, and the sutures cut out. Moreover, the rectum cannot be prepared properly for the operation. I know of two instances where fatal suppurative pylephlebitis followed the precipitate removal of strangulated piles.

Summary. Seen within a few hours after prolapse, the hæmorrhoids should be replaced after well oiling the part. Do not persist too long in manipulations which do not promise to be successful and are very painful.

Fig. 290. After reduction has been accomplished the buttock strapped together with broad adhesive plaster.

If reduction is unsuccessful, give the patient a low spinal anæsthetic, stretch the sphincter, and return the hæmorrhoids.

In most cases which have persisted for more than twelve hours, postural treatment and fomentations will give relief and the prolapsed hæmorrhoids will reduce themselves gradually.

Do not attempt to remove strangulated hæmorrhoids in the acute stage.

The Thrombotic Pile. The so-called thrombotic pile is due to the bursting of an anal venule. A swelling which has been aptly likened to an over-ripe cherry is observed on one side of the anal orifice. When seen soon after its first appearance the patient will be spared much inconvenience and pain if the condition is treated as an emergency. Under gas or low spinal anæsthesia a small incision is made over the centre of the swelling and the blood-clot is squeezed out. An antiseptic dressing, and instructions to wash the part after defæcation for at least a week, complete the treatment.

Hæmorrhage after Operation for Hæmorrhoids. Some years ago, whilst I was acting as a pathological assistant, a male subject, aged

44, came to necropsy. An operation for internal hæmorrhoids had been performed three days previously. The whole of the large gut from the cæcum to the sphincter ani was full of blood. A clinical note stated that there had been no external hæmorrhage. Binnie, in his *Operative Surgery*, disparages the use of a rubber tube wrapped in gauze as a dressing after operation for hæmorrhoids. " This dressing ", he says, " ought to be reserved for personal enemies and malefactors, as it does no good." Had this tube dressing been employed in the case cited above, it might have been instrumental in saving the patient's life, for the blood, instead of passing backwards into the colon, would have appeared externally.

In October, 1924, I was summoned in the middle of the night to a woman who had had hæmorrhoids removed during the previous afternoon. Through the drainage tube which had been placed in position blood had continued to drip, and the pulse was rising steadily

Fig. 291. Type of slotted rectal speculum, referred to in the text.

in spite of the morphia which had been given. A general anæsthetic was administered, and a slotted rectal speculum (*Fig.* 291) inserted through the sphincter. With a headlight the interior of the rectum was examined. A spurting vessel was discovered at the top of one of the suture lines. The bleeding point was caught with a long hæmostat and ligatured. A tube wrapped in gauze soaked in glycerol was inserted through the anus. Recovery followed.

SIGMOIDO-RECTAL INTUSSUSCEPTION OF OLD PEOPLE

In the only example of this condition which I have encountered, reduction was possible.

M. G. was a thin, wiry female of 88. Two hours before admission, whilst straining at stool, she noticed a lump appear at the anus. This got larger and larger, but there was no pain. When examined there was a mass of prolapsed mucosa the size of a baby's head protruding from the anus. There was no shock. Under gas and oxygen anæsthesia, little by little the mass was returned. Once the first part of the mucosa could be replaced, the remainder followed with comparative ease. After reduction had been effected, the buttocks were strapped together with adhesive plaster. Recovery.

Zachary Cope's Case.—

The patient was a man of 82. The symptoms, which included the passage of a large quantity of mucus, had been present for six days. Reduction was attempted, but as this failed the abdomen was opened. Gentle traction from above and pressure from below by an assistant with a finger in the rectum also proved ineffective, so left inguinal colostomy was performed. The colostomy was not opened. A few days later the patient had his bowels opened naturally, and on examination it was found that the intussusception had disappeared, so instead of opening the colostomy it was allowed to fall back. Recovery.

Gradual reduction had evidently been accomplished by the constant traction caused by the colostomy. Cope puts forward this method, which was found accidentally, as a means of treating like cases.

RECTAL PROLAPSE OF CHILDREN

Treatment.—Put the child across the knee, and after well oiling the part, with finger and thumb squeeze back the protruding membrane. An anaesthetic will seldom be required. It is a good practice to strap the buttocks together, and for the first few days, at any rate, have the child defaecate lying flat or on its side, after which the buttocks are again strapped together.

In every case of prolapse the rectum should be examined thoroughly for a polypus.

Imperforate Anus. *See* p. 242.

Intussusception Protruding from the Anus. *See* p. 255.

Alarming Rectal Haemorrhage. *See* p. 259.

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CHAPTER XXII

SOME POST-OPERATIVE COMPLICATIONS WITH SPECIAL REFERENCE TO ABDOMINAL OPERATIONS

"THE more one sees of the practice of surgery the more one is impressed by the relative frequency of unforeseen complications, and when one carefully thinks out the cause of these troubles it is only to find that most of them could be prevented." — *John H. Watson.*

THROMBOSIS AND EMBOLISM, WITH SPECIAL REFERENCE TO PREVENTION

The frequency with which the tragedy of pulmonary embolus carries off a patient who has undergone an operation successfully several days or weeks before, impels the conscientious surgeon to take action in order to try and prevent the catastrophe. Patients nursed in Fowler's position are definitely more prone to venous thrombosis of the lower extremities, particularly if a 'donkey' is used beneath the knees. Deep breathing exercises are helpful in the prevention of venestasis. The nurse should be instructed to move the knee-joints at least once a day, and to keep a sharp look out for any swelling of a limb. Once there are signs of thrombosis the limb must be elevated on an inclined plane.

It seems clear that some individuals are prone to thrombosis while others are immune, even though the disease and the operation was near the vulnerable internal iliac veins. G. Bankoff considers the thrombosis-prone group can be singled out by injecting 1 c.c. of thyroxine. An individual who is prone to post-operative thrombosis is 'thyroxine sensitive'. This involves pre-operative laboratory tests, which do not concern us here because they are out of the question in emergency cases. According to Bankoff, hypodermic injections of atropine and ephetonine, in a proportion of $\frac{1}{100}$ gr. of atropine to $\frac{1}{4}$ gr. of ephetonine, prevent the liability to thrombosis and can be given both to the thyroxine sensitive and the thyroxine resistant with impunity. Not less than three injections in all should be given every other day, commencing from the fifth day after operation.

POST-OPERATIVE FLATULENCE

Flatulence causes much post-operative discomfort. A rectal tube can be passed, and if this is not effective and there is no

contra-indication, a small enema may be given. Oil of cajuput 1 min. is of definite value in helping the patient to pass flatus. There can be little doubt that post-operative flatulency is a mild degree of paralytic ileus. Two or three doses of acetylcholine 0·1 grm. every two or three hours sometimes proves helpful. By mouth a simple carminative such as the following may be prescribed :

R   Aspirin   gr. xv   Sal. Volat.
    Sod. Bicarb.   ℥ss   Aq. Menth. Pip.   ad ℥ss

PARALYTIC ILEUS

It must be remembered that in this condition the gut has already received its normal stimulus—to wit, distension   in excess, and has not responded. All measures which stimulate peristalsis   calomel, saline purgatives, castor oil, eserine, pituitrin   are bound to act most effectively on the comparatively normal upper coils of small intestine. Whether these stimulants have any effect on the paralysed gut below (*Fig.* 292) is very questionable. Their effect is to force more fluid into the cesspool near the ileocaecal valve (Molesworth).

If the diagnosis of ileus paralyticus is assured, absolute rest, no purgatives, no pituitrin, and water only, is the treatment which I favour. Anti-gas-gangrene serum is given, and repeated in twelve hours. If the diagnosis is quite certain, morphia may be given in post-operative cases. If vomiting is in evidence, the stomach contents should be aspirated and tap water per rectum ordered : 0·1 grm. of acetyl-choline by intramuscular injection every two hours can be tried. Lawrence Abel has had
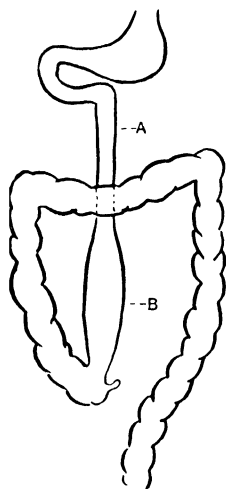
Fig. 292.   Diagram showing the me   n of failure of the treatment of paralytic ileus by ex   peristalsis. **A.** Comparatively healthy small intesti   bly excited by purgatives ; **B.** Paralysed intestin   citable by purgatives. (*After Molesworth.*)

much success with this drug, which does not come in the category of a purgative.

Although it is admittedly intensely worrying if the bowels do not act, I am convinced that it is harmful to the patient to give repeated enemas. A rectal tube may be tried, but as this usually coils up in the rectal ampulla it is often without value. Far better is it to wait until the following morning and then order one turpentine enema. The night's rest may give the gut back its motive power, and the period of anxiety will then be at an end. If the bowels do not act, more anti-gas-gangrene serum and more rest is indicated.

Cajuput oil, 1 min., may be ordered to help the patient to pass flatus, and this can be repeated; it is often effective. On the following morning another turpentine enema is given. If there is still no result, but the patient's condition is not deteriorating, a further twenty-four hours of rest is ordered, but this time the enema is preceded by a hypodermic injection of 1 c.c. of pituitrin, which is not repeated. I have seen several cases of severe paralytic ileus recover with rest, but have not had a success with ileostomy, and several times I have regretted operating.

Spinal Anæsthesia as a Means of Treatment. Everyone who has employed spinal anæsthesia has encountered cases where, after the injection of the anæsthetic, the bowels have moved freely. Studdiford advises the employment of spinal anæsthesia as a means of treatment for paralytic ileus, and this author has had some excellent results in intractable ileus following parturition. Spinal anæsthesia certainly seems a rational line of treatment, particularly in those cases in which difficulty in diagnosis is experienced and exploratory operation contemplated. If the bowels do not act under the spinal anæsthesia, then operation is carried out.

The chief difficulty in dealing with this condition is in the diagnosis. It should be ever before one, especially in cases of appendicitis, that distension and obstructive symptoms commencing *within the first three days* after operation are usually due to paralytic ileus. True intestinal obstruction usually comes on *between the sixth and the tenth day*. It is sometimes supremely difficult to decide which of these two conditions is present. In such cases I give 1 c.c. of pituitrin, wait half an hour, and then order an enema. If the bowels are not opened, or if the patient vomits as the result of the pituitrin, operation is carried out under spinal anæsthesia, not forgetting the possible relief of ileus by the administration of intrathecal anæsthesia. If on opening the abdomen no definite organic obstruction is found but the coils are matted by plastic peritonitis, ileostomy or jejunostomy is performed. If the coils are free, the abdomen is closed promptly.

In obscure cases of ileus paralyticus it is well to remind the reader to exclude uræmia.

When Intestinal Obstruction Cannot be Excluded. Reference has just been made to the great difficulty in diagnosis. In certain cases it is impossible to distinguish between paralytic ileus and intestinal obstruction. In some cases of plastic peritonitis, indeed, one condition merges into the other. If intestinal obstruction cannot be excluded, or if the patient's general condition is deteriorating, then jejunostomy under local anæsthesia is indicated (*see* JEJUNOSTOMY, p. 224).

POST-OPERATIVE RETENTION OF URINE

Post-operative retention is a somewhat common complication after operations for strangulated hernia and after spinal anæsthesia. When called to a patient whose abdomen is stated to be distended after an abdominal operation, remember the full bladder. I have found this of practical value over and over again. It is not sufficient to inquire if the patient has micturated; he may say he has passed water. In order definitely to exclude a full bladder, which is not rarely the cause of a distended abdomen after operation, a catheter must be passed before other possibilities are considered.

In post-operative retention the first thing to aim at is to try to get the patient to pass urine naturally. Proctoclysis definitely favours retention; when the rectal tube has been removed the patient sometimes passes urine naturally. A hot fomentation is applied to the hypogastrium, and liquor potassii acetatis, ʒss of the 1 15 solution, is given every half hour for eight doses if required. Potassium acetate is a parasympathetic stimulant as well as a diuretic. If this is not effective, a catheter must be passed, with every aseptic precaution, for it must be remembered that cases of post-operative retention are particularly liable to cystitis and an ascending infection. Armed with this knowledge, we place the patient on a course of urinary antiseptics. Should repeated catheterization be necessary and the patient is a man of over fifty, the possibility of an enlarged prostate should be entertained. In such cases I introduce a catheter suprapubically (see p. 370) in preference to repeated catheterization.

POST-OPERATIVE PNEUMONIA

Prevention.—It is most important to take every precaution to prevent this very serious complication. The pre-operative aspiration of stomach contents helps to make the anæsthetic safe. Patients with a tendency to bronchitis should not have an anæsthetic via the respiratory passages if it can be avoided.

See to it yourself that the patient is wrapped up adequately on leaving the theatre. In the winter put hot-water bottles around him during his transit from theatre to bed.

As a routine after operations for conditions which are known to be associated with a high incidence of pulmonary complications—e.g., perforated peptic ulcer, strangulated para-umbilical hernia—I order the patient to blow water from one Wolff's bottle to another (*Fig.* 293) in order to keep the bases of the lung expanded. The patient is started on this exercise on the day of operation, and three times each day for five or six days she blows the water from one bottle to the other.

Another precautionary measure to which I attach much importance is that, if a patient on coming round from the anæsthetic (and

for twelve hours afterwards) is noticed to be what is colloquially known as 'bubbly' (which signifies that the bronchioles are full of mucus), atropine $\frac{1}{100}$ gr. together with 5 min. of adrenaline should be promptly administered subcutaneously. These drugs must not be repeated by those in attendance unless ordered expressly.

Fig. 293. Patient after operation for strangulated para-umbilical hernia blowing water from one bottle to another in order to expand the bases of the lungs.

A proportion of cases, probably a high proportion, developing 'pneumonia' or 'pleurisy' suddenly and for the first time between the fifth and tenth days after operation have, in reality, had a small pulmonary embolus, and are in danger of a larger embolus following.

The treatment of post-operative pneumonia, once it has developed, differs not at all from other types. Whenever possible a medical colleague should be asked to superintend the treatment.

PERSISTENT HICCUP

Persistent hiccup is a distressing complication, most often seen after upper abdominal operations, although it is by no means rare in uraemic subjects. It is a serious complication, distressing for the wretched patient, upsetting to the other patients, and distracting to the staff.

Fig. 294. The Sparklet 'Resuscitator' for administering CO_2.

Morphia sometimes controls it for a time, but persistent hiccup is almost untouched by this drug.

The best treatment is to get the patient to inhale air containing an excess of CO_2. A homely method is to get him to breathe in and out of a thin paper bag for half a minute or so at a stretch. When available the administration of CO_2 by an apparatus designed for the purpose is often effective (*Fig.* 294).

Inhalations should be given for from three to fifteen minutes, and charted thus:

TIME	5 PER CENT MIXTURE INHALED FOR	FREEDOM FROM HICCUP
3.30 a.m.	10 minutes	20 minutes
4 a.m.	5 ,,	30 ,,

As a last resort, the advisability of exposing the phrenic nerve and injecting it with alcohol should receive consideration.

ACIDOSIS
(*Ketosis*)

Acidosis is a well-known complication after general anaesthesia in children.

Rothera's Test for Detecting Aceto-acetic Acid in the Urine. —To 5 c.c. of urine add an equal volume of a saturated solution of ammonium sulphate. Then add 2 c.c. of liquor ammoniae, and after this a few drops of 5 per cent solution of sodium nitroprusside. A rich purple colour signifies that aceto-acetic acid is present in the urine.

Prevention. —After emergency operations on little children it is a good practice to order saline and glucose per rectum.

Acidosis should be suspected when vomiting for which there is no apparent reason continues for more than forty-eight hours after operation and the patient is a little child. A characteristic odour of new-mown hay in the child's breath helps to confirm a suspicion of acidosis.

Treatment.—It is of the utmost importance to get glucose promptly into the circulation. Six to eight ounces of a 10 per cent solution of glucose in saline are given slowly per rectum. This is repeated every four hours. The nurse must be told to report if the solution is not retained. If this is the case, a 5 per cent solution of glucose may be given subcutaneously. In urgent cases 5 per cent solution may be given intravenously. The stomach should be washed out if vomiting continues, using Ryle's small stomach tube.

Other Forms of Treatment. —Sodium bicarbonate in large doses is useful, and insulin is stated to be of value. Regarding the administration of the latter, it is advisable to seek the help of a medical colleague.

FÆCAL FISTULA

Fæcal fistulæ are produced in a number of different ways. Amongst the more important are the giving way of a gangrenous patch of intestine after obstruction has been relieved, and the erosion of bowel by the proximity of a drainage tube.

A patient has been recently operated upon, and we are called because a fæcal fistula is reported by the nurse. The first thing is to satisfy ourselves that it is really a fæcal leak. Many times a fæcal fistula is reported when in reality foul, fæcal-smelling pus has been discharged from the wound. The passage of flatus with the discharge is proof positive of a communication with the bowel.

A fæcal fistula is generally to be regarded as a most unfortunate and disagreeable complication. There are occasions, however, though few and far between, when its manifestation is not displeasing. " If a patient with peritonitis develops a fæcal fistula he does not die " was a *bon mot* of a former colleague of mine. There is an element of truth in this aphorism when applied to cases of advanced peritonitis with meteorism. The fæcal fistula acts as an enterostomy.

Management of a Fæcal Fistula.—The skin around the wound must be protected from erosion. Dressings of horse serum are useful, and overlapping these, and extending more widely, are placed several layers of gauze with vaseline spread on the under surface.

Pulv. cret. aromat., ʒj four-hourly by mouth, makes the intestinal contents more viscid, and mitigates their offensiveness. This powder is most useful in the expectant treatment of fæcal fistula. It should be noted that the patient soon seems to get a tolerance to the powder, but the dose can be increased as necessary. 'Corsets', such as those illustrated in *Fig.* 55, p. 51, should be placed in position in cases where there is a laparotomy wound likely to break down and burst open.

In a number of instances, conservatism, attention to the skin, enemata, pulv. cret. aromat. by mouth, and careful nursing will be rewarded by spontaneous closure of the fistula. The spontaneous closure of a fæcal fistula is, to my mind, one of the most remarkable and pleasing phenomena seen in surgical practice.

W. W., aged 28, was admitted with a strangulated recurrent left inguinal hernia. Herniotomy was performed. The gut recovered fairly well, except for a portion about two inches in length. This was invaginated. On the eleventh day a fæcal fistula developed. The discharge was extremely profuse, and it appeared that the fistula was giving exit to most if not all of the intestinal stream. Treatment on the lines outlined above was carried out. The fistula soon began to discharge much less, and the patient left hospital with the wound soundly healed four weeks later. When seen a year later there was no recurrence of the hernia.

G. B., aged 57, a large, fat man, underwent an operation for a multi-locular incisional hernia. The gut was adherent to the scar in several places, and during the separation of one of these loops the intestine was wounded. This was sewn up. At this stage the patient's condition became critical. After artificial respiration the wound was hurriedly brought together with through-and-through sutures, and he was returned to bed. With cardiac stimulants his condition improved. On the third day a profuse fæcal discharge appeared at the lower end of the wound. Treatment was carried out as above. The fæcal fistula closed spontaneously on the thirteenth day. On the fifteenth day the stitches were removed. Surprising to relate, the abdominal wall healed soundly with no trace of the hernia.

The Obturator Method of Hastening Spontaneous Closure. To hasten spontaneous closure the following method, described by R. J. McNeill Love, is often very effective, and should be tried in all cases before operation for closure of the fistula is advised.

A disc of the inner tube of a motor tyre is cut to the size of a half-penny in the case of the small gut, or a penny, or larger, if the fistula is of the cæcum or colon. The disc is transfixed near its centre by a mattress suture of silkworm gut. The disc is now rolled tightly between the thumb and finger. The resultant scroll is grasped with sinus forceps and inserted along the fistula. With a little manipulation the scroll is introduced into the lumen and on withdrawing the sinus forceps the elasticity of the rubber causes the scroll to open. Traction on the silkworm suture approximates the disc to the wall of the bowel and so prevents fæcal contents from escaping along the fistula. The free ends of the suture are tied around a small roll of gauze, and thus the disc is fixed in position. When healing of the fistula is practically complete one end of the suture is cut, so that the remainder can be withdrawn, and the disc, thus set free, passes uneventfully along the bowel and subsequently is evacuated.

When the mucous membrane can be seen pouting above the skin level in a fæcal fistula, whether of the small or the large intestine (e.g., cæcostomy), the hope of spontaneous healing can be almost abandoned. In such cases the closure of the fistula by operation must be planned, but this is in no sense an emergency measure. On the contrary, it is wise to postpone operation for many weeks.

Operative Treatment. There remains a small but definite group of cases which demands our close attention. A fæcal fistula is present in the mid or lower part of the small intestine. The discharge is profuse, and the patient is losing ground from lack of nourishment. With rectal saline and glucose and nutrient enemata his condition will temporarily improve. Now is the time to act. Various operations may be designed to suit particular circumstances, but speaking generally the following can be recommended, particularly if the fistula is situated in the lower ileum. Assuming that the fistula is below the level of the umbilicus, twenty-four hours before operation the

abdomen should be cleansed thoroughly, after which spirit dressing followed by tincture of iodine, or if preferred the old carbolic compress, is applied. The point is that very special preparation is necessary, for the skin of the abdominal wall is grossly contaminated with faeces. During this period of preparation of the skin as much nourishment as possible is administered by the rectum. Saline is given during the operation.

After isolating the upper abdomen with towels clipped to the skin, a mid-line incision is made and a coil of jejunum found. The small intestine is run through the fingers until on gently pulling we come to a full stop. This is in all probability the segment which is adherent to the abdominal wall and is leaking. At a convenient spot above this area divide the gut completely between two small Payr's clamps. Close both ends of the divided intestine. Then perform lateral ileo-transverse colostomy. The fistula can now only discharge a little mucus at the most.

It requires nice judgement to select the correct time to operate. If the fistula is starving the patient, do not let conservatism (which acts so admirably in the majority of instances) run riot. There is usually one opportunity to operate with a fair promise of success, and that is after the temporary improvement which follows rectal feeding and saline. This chance, once lost, is irrevocable.

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CHAPTER XXIII

THE KIDNEY AND URETER

RENAL COLIC

Is it renal colic? that is the important question. Many cases are unmistakable, and all that is required immediately is a suitable dose of morphia and atropine. In the less striking examples an intra-peritoneal lesion has to be excluded, and it is then that the surgeon's diagnostic powers and judgement are taxed to the fullest degree. When in doubt a good practice is to prescribe a hot bottle and perhaps a dose of atropine—but never morphia—and to re-examine the patient in half an hour. During the interval the urine should be examined again. If facilities exist urgent chromo-cystoscopy or an excretion pyelogram sometimes enables one to exclude or clinch the diagnosis of renal colic. When, after trying his best, the surgeon cannot be sure that pain and rigidity are *not* due to early acute appendicitis or other intra-abdominal catastrophe, an immediate exploratory operation is more than justified, especially if a second opinion has been obtained.

ACUTE PYELITIS

Here again similar difficulties in diagnosis are only too common. Fortunately, there are often symptoms, such as increased frequency of micturition, and findings, such as pyuria, which distinctly favour a confident diagnosis. In early cases where the diagnosis is in doubt and no help has been derived from an examination of the urine, I have, in a few instances, performed urgent cystoscopy and obtained by ureteric catheterization a specimen of urine from the right kidney. This has been centrifuged. If pus cells are found it makes the diagnosis of pyelitis very probable. After twelve hours such findings by them-selves cannot be regarded as conclusive. In acute appendicitis, when a retrocaecal appendix lies alongside the ureter, pus, and even blood, can be present in the urine. I have met with several examples of this kind, and they are exceedingly confusing.

Treatment of Acute Pyelitis. For the relief of the pain of pyelitis pituitary extract, ½ to 1 c.c., is more effective than ¼ gr. of morphia. The patient should be placed on copious fluids. She should be encour-aged to drink a glass of fluid every half hour during the day and every hour during the night while awake. No time must be lost in alkalizing

the urine. Two drachms of potassium citrate should be given every two hours until the urine becomes alkaline. The only way of telling this is to test the urine with litmus. In severe cases of acute pyelitis intravenous urotropine (Schering) is exceedingly effective. Five c.c. of a 40 per cent solution are injected intravenously daily until the
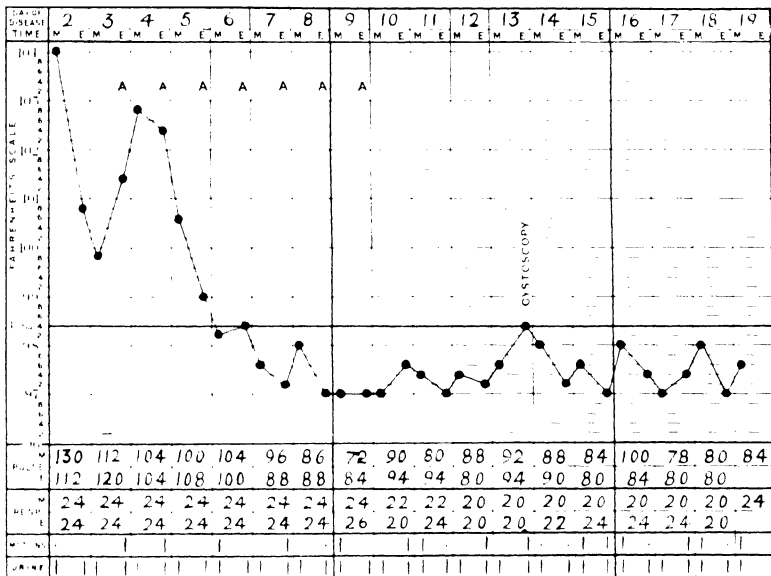
ure chart of a case of acute pyelitis treated by ntravenous urotropine (A).

temperature falls (*Fig.* 295). When the acute stage has abated somewhat, which will be about the fifth or sixth day, an acid tide in the urine is produced by the following mixture :

Acid Ammon. Phos.
Syr. Limonis
Aq. ad.   ℥ij
          t.d.s., or oftener, p.c.

Acid ammonium phosphate is a better acidifier of the urine than sodium acid phosphate. Now is the time to prescribe a urinary antiseptic, of which there are a bewildering variety. Neotropine, 2 capsules t.d.s. p.c., is often effective. When neotropine has been administered the urine becomes a brilliant orange in colour. After the fifth day the drug should be discontinued for a day or two, at least.

PYELITIS OF PREGNANCY.

The same principles in treatment are invoked. Ureteral catheterization, leaving the catheter in place for forty-eight hours and washing out the kidney pelvis with normal saline, has been found to be efficacious by some authorities.

GENERAL TREATMENT OF OLIGURIA AND URÆMIA.

All patients suffering from urinary obstruction or urinary sepsis have some degree of uræmia. After the local condition has been relieved, attention should be directed at once towards reducing the uræmia. This is a most important part of the treatment of the case, and one to which, as a rule, too little attention is paid, especially after acute retention of urine has been relieved.

Mild Cases.—The patient should be encouraged to drink as much fluid as possible, and the fluid intake must be supplemented by a continuous rectal drip of tap water. Urinary antiseptics are prescribed as the needs of the case demand. The total amount of urine excreted during each twenty-four hours must be measured and charted. It is advisable to have the blood urea estimated and to watch the patient carefully for signs of renal failure.

Severe Cases.—Sweating, as Hugh Cabot has shown, merely depletes the tissues of much needed water and salts. As a means of ridding the patient of urea it is puerile. Diaphoretics are therefore useless, and even harmful. What the patient requires is a diuretic, and there is no better diuretic in the Pharmacopœia than the continuous administration of saline and glucose*. It is therefore advised strongly to administer this without delay.

Desperate Cases.—Commence with venesection. Withdraw a half to one pint of blood. Then introduce a continuous intravenous saline needle and allow half to one pint of saline and glucose to run into the vein fairly rapidly. When the volume of circulating blood has been restored, cut down the rate to the regulation 25 drops per minute. If improvement in the general condition and the outflow of urine is not manifest within six hours, further venesection, followed by a blood transfusion, should be entertained. At this juncture the advisability of decapsulation of the kidneys (p. 334)—a most difficult question—must receive consideration. If the patient's general condition is even moderately good and the foregoing treatment has failed to produce an adequate output of urine, decapsulation offers the only hope of a successful issue.

(*See also* Calculous Anuria, p. 330.)

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* This is not quite correct ; an isotonic solution of sodium sulphate is a better diuretic than sodium chloride ; 42·85 grm. of Glauber's salt dissolved in a litre of water give an isotonic solution. It is administered continuously into a vein precisely as normal saline. (*Dick.*)

EXPOSURE OF THE KIDNEY BY THE LUMBAR ROUTE

Position of Patient. The prone position (*Fig.* 296) will be found most satisfactory. The position offers two advantages. Firstly, the kidney can be cut down upon rapidly. Secondly, the opposite side is available immediately if it should be necessary to explore the contralateral organ, e.g., nephrostomy, renal decapsulation. When the time comes for closure of the wound, the bridge of the table is lowered, or the bags are deflated.

Fig. 296. The prone position for exposing the kidney in the loin. In this illustration the patient is lying on a Newman's tripartite bag. The elevation of the 'bridge' which is fitted to most modern operating tables gives adequate flexion and the bag becomes unnecessary.

Mayo's Incision. One of several advantages of Mayo's incision is that comparatively few blood-vessels are encountered during the exposure of the kidney.

This incision commences over the centre of the erector spinæ at the level of the upper border of the twelfth rib, and passes directly downwards for 3 in., where it curves outwards to form a J (*Fig.* 297).

1. The erector spinæ sheath is incised vertically, and the erector spinæ muscle is retracted medially.

2. The deep aspect of the erector spinæ sheath is incised longitudinally.

3. The quadratus lumborum is retracted medially.

4. The extraperitoneal fat and peritoneum are pushed laterally.

5. The fascia of Zuckerkandl is torn through, and the perirenal

fat is cleaned by blunt dissection from the capsule of the kidney.
During these manipulations the twelfth dorsal nerve is preserved
carefully.

If more room is required, ligaments uniting the twelfth rib to the
vertebra are divided, and the twelfth rib is pulled upwards. If still
more room is needed the twelfth rib may be excised subperiosteally.

Fig. 297. —Mayo's incision for exposure of the kidney.

Delivery of the Kidney (*Fig.* 298).— It is a great mistake to
attempt to haul the organ out of the wound. The lower pole, after
being thoroughly cleaned and thereby freed, is brought to the surface.

Fig. 298. —Delivery of a kidney. The lower pole is delivered first ; gauze
packing is inserted into the wound to prevent this slipping back whilst the upper
pole is delivered. Always deliver a kidney one pole at a time.

If a gauze pack is inserted into the wound under the lower pole of the kidney, there is little likelihood of its slipping back at the critical moment. The upper pole is delivered similarly. Always deliver the kidney one pole at a time.

LUMBAR NEPHRECTOMY

Apart from rupture, the indications for nephrectomy as an emergency procedure are very few and far between. Without the advantage of having investigated the function of each kidney by refined methods, nephrectomy should seldom be even contemplated. If it is necessary to operate at short notice upon a pyonephrosis, simple nephrostomy should be performed. Failure to observe this general principle has led to disaster.

Once the kidney has been delivered, its removal, in cases of rupture, is simple. Working from below upwards, the individual constituents of the pedicle are clamped with ordinary long hæmostats and cut—a section at a time (*Fig.* 299). The clamps may be placed
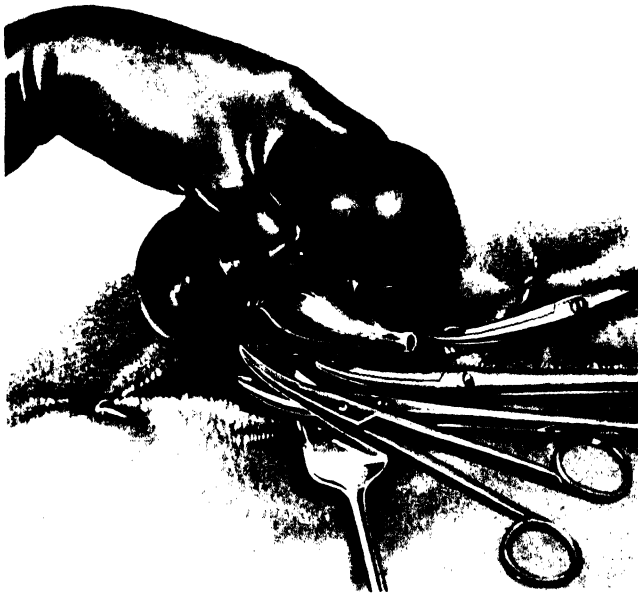
Fig. 299. Nephrectomy. The segmental division of the renal pedicle should be noted. This is much safer than a mass ligature.

quite close to the kidney. This technique is far better than the mass ligature, and makes slipping of the renal pedicle practically impossible.

Partial Nephrectomy. —

Indications.—

1. Rupture of the kidney when the damage is confined to one pole.

2. Carbuncle of kidney when the abscess is localized in one pole.

As much as one-third of the kidney can be resected. If possible, when resecting, remove a wedge-shaped portion, leaving a V. Into this V place a piece of muscle taken from the erector spinæ and suture over this (*Fig.* 300).
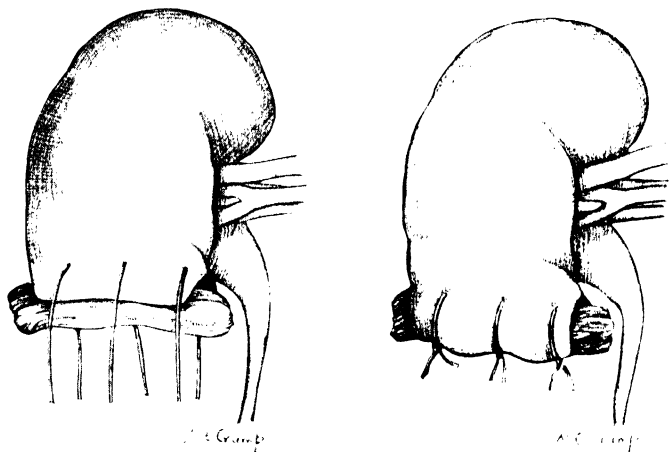
Fig. 300. Partial nephrectomy. Repaired by suturing over a muscle graft.

Severe Hæmorrhage during and after Nephrectomy. —

Hæmorrhage during Nephrectomy. Mayo has immortalized the slipped renal pedicle, which, he says, " fairly jumps into the fingers " when nimble fingers promptly follow its retraction into the depth of the wound. It would seem that a potent cause of slipping of the pedicle is the use of a single, large, and consequently clumsy, clamp.

Tearing of the inferior vena cava is another disaster during right-sided nephrectomy. It is usually associated with difficulties in delivery of an adherent right kidney with a short pedicle. The danger is minimized by making the incision sufficiently large and mobilizing the twelfth rib, thereby giving proper room in which to work. Attempts to apply a ligature usually result in tearing the vessel walls still further. Priestley and Walters consider that a hæmostat applied accurately to the tear, but not occluding the vena cava, is the most satisfactory and practical method of dealing with the situation. The handles of the hæmostat are left projecting from the wound and the instrument is left in place for a whole week. The ratchet is then loosened, but

the hæmostat is still left in place till the eighth day, when it can be removed in almost every case without further bleeding.

Hæmorrhage after Nephrectomy. If bleeding occurs some hours after nephrectomy and recurs in spite of morphia, the wound must be reopened and the bleeding point sought. Often it is difficult to locate and recourse must be made to packing the wound with gauze. The portion of gauze which is first introduced may with advantage be moistened with turpentine.

SEVERE HÆMORRHAGE AFTER NEPHROLITHOTOMY

In my case index for June, 1922, there is the following entry: " During this month I have seen three cases of severe hæmaturia following nephrolithotomy. In all of them the condition of the patient was alarming, and did not respond to morphia. X remarked that these cases do not die. All recovered." A little more than two months later a fourth case came under my notice, and it was not until the profoundly anæmic patient died upon the eighth day that I lost faith in my new-found aphorism. Two years intervened before another opportunity occurred of studying this condition.

L. F., aged 47, had left nephrolithotomy performed. By X rays a cluster of stones in the pelvis and lower pole of the left kidney had been shown. Three large branched calculi were extracted after splitting the kidney longitudinally. Fairly profuse hæmaturia persisted until the fifth day, but on the sixth day it appeared to be clearing, and there was little to call attention to the patient until the morning of the twelfth day, when 10 oz. of almost pure blood were passed. On the three succeeding days the same thing occurred each morning, in spite of large doses of morphia. The general condition of the patient became alarming. He was placed upon an hourly pulse-rate, and as this showed a steady increase, on the evening of the fifteenth day he was transfused with 200 c.c. of

Fig. 301. Kidney removed for profuse hæmaturia following nephrolithotomy by splitting the kidney—an obsolete method. Areas of infarction can be seen.

blood, and left nephrectomy was performed. The perinephric space and the
interior of the kidney were full of blood-clot. Drainage. Recovery.

Fig. 301 shows the specimen. The extensive anæmic infarction
on either side of the longitudinal wound is good evidence that 'post-
mortem splitting' of the kidney is a poor surgical procedure. A
transverse incision, which more nearly follows the ramifications of
the intrarenal vessels, is not open to this objection.

ABDOMINAL NEPHRECTOMY

Particularly in emergency surgery, the indications for abdominal
nephrectomy are limited. It will be found of service   the rare cases
of intraperitoneal   e of the kidney, or where the kidney is found
to be ruptured in addition to some intra-
peritoneal lesion (*see* Chapter XIII).

In torrential hæmaturia of renal
origin abdominal nephrectomy may some-
times be resorted to, as was done in the
following case :

A. W., aged 50, gave the following
history. Eighteen years previously she had
a cyst removed from the right kidney. Four
years afterwards the same kidney had been
fixed. For the past three years attacks of
painless hæmaturia had occurred, but during
the past six weeks the bleeding had occurred
daily. During the four days immediately
preceding, the doctor in attendance stated
that pure blood had been running away like
a tap. The patient was quite blanched, com-
plained of singing in her ears, and seemed
wandering in her statements. The pulse was
very feeble, and all that could be found on
physical examination was the scar of previous
operations in the right loin. Blood trans-
fusion was carried out the same evening. On
the following morning her general condition
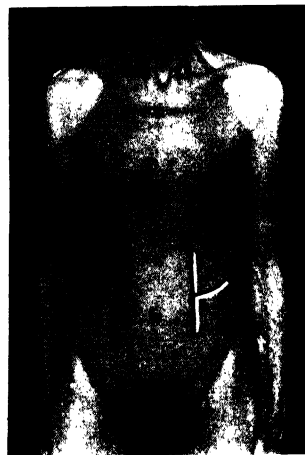
Fig. 302.—Incision for ab
dominal nephrectomy. If mor
room is required the transvers
extension is made.

had somewhat improved, but the urine was full of blood. Under a general
anæsthetic, after repeated washings, cystoscopy showed a blood-clot in the
orifice of the right ureter. The abdomen was opened by a right rectus
incision, which was in turn converted into a Rutherford Morison's incision
by a transverse cut outwards. The right kidney was ill-formed and adherent.
The left felt normal. Abdominal nephrectomy. Recovery. The patient
was alive and well two years later. Serial sections of the kidney failed to
reveal the cause of the hæmorrhage.

An advantage of abdominal nephrectomy is that it permits
examination by palpation of the opposite kidney. It is, however,
a dangerous route to traverse if there is any question of the lesion
being inflammatory. The operation is distinctly difficult in the

presence of meteorism, or when the anaesthetic has not rendered the abdominal wall flaccid. Abdominal nephrectomy can be carried out through an incision similar to Battle's incision, though placed higher (*Fig.* 302). The incision must be of ample proportions, and if it is found that more room is required a transverse cut can be made towards the flank (*Fig.* 302). The peritoneum having been opened, the intestines are packed off carefully. The posterior layer of the peritoneum is now incised on the lateral side of the colon. It is highly important to be absolutely certain that this incision is made on the *outer* side of the large gut, otherwise the blood-supply to that part of the colon will be jeopardized. By gauze dissection the colon and its mesentery are mobilized towards the middle line. The kidney is now accessible. The renal pedicle is ligated in sections. After the kidney has been removed the peritoneum of the posterior abdominal wall is closed, but it is usually a wise precaution to drain the perirenal space by a stab incision in the loin before carrying out this measure.

Torsion of an Ectopic Kidney. Abdominal nephrectomy has to be performed occasionally as an emergency for torsion of a mal-placed organ, of which the following is a good example :—

B. N., aged 17, was admitted to hospital at 5 a.m. one autumn morning. He gave a history of a sudden onset of abdominal pain thirty-six hours previously. The pain *began* in the right side. He had vomited four times. The pulse was 104 and the temperature 99°. There was rigidity, tenderness, and hyperaesthesia in the right iliac fossa. A diagnosis of acute appendicitis was made, but as the pain had *begun* in the right iliac fossa, it was mentally noted that this was the only unusual feature in an otherwise typical case. The urine was normal. At 8 a.m. he was anaesthetized. Under the anaesthetic a large lump could be felt in the right iliac fossa, which, it was thought, might be an appendix abscess. Gridiron incision showed a round, purple, retroperitoneal swelling about the size of a tangerine. The incision was enlarged downwards by detaching the internal oblique from the rectus sheath. A hand was passed into the abdomen, and it was noted that the right kidney was absent from its normal position, whereas the left kidney was large and normally placed. The lump was therefore the (small) right kidney. The intestines were packed off

Fig. 303. Torsion of an ectopic kidney. Drawing of a specimen removed at operation.

medially, and the caecum was mobilized a little and then packed away into the upper part of the wound. The peritoneum was incised over the swelling, and a very deformed, rounded kidney delivered, the pelvis of which was extremely dilated (*Fig.* 303). A twist was noted in the ureter, and on turning the kidney through a complete clockwise circle the ureter straightened out

and the tense pelvis discharged its contents into the bladder. The ureter was so short that there was no hope of placing the organ in the loin, so nephrectomy was performed by dividing the ureter between clamps, and likewise the renal vessels, which entered at the upper pole diametrically opposite the ureter. The peritoneum of the posterior abdominal wall was then brought together and the abdomen closed. Recovery.

CALCULOUS ANURIA

That the condition is one of anuria may be suspected when a patient has passed no urine for a considerable time, yet the signs of a distended bladder are wanting. The suspicion is confirmed by the passage of a catheter.

Calculous anuria usually supervenes in one of the following ways : (1) Both ureters become blocked with stones ; (2) A calculus becomes impacted in the ureter of a sole existing kidney, the other kidney being congenitally absent, previously removed, or destroyed by disease.

As is well known, there is a period of tolerance during which the patient, although in fairly good condition, passes no urine. I watched a boy of 14 who had had nephrectomy performed upon what proved to be his only kidney live fourteen and a half days without passing one drop of urine. Do not let this very variable period of tolerance deceive you into temporizing and wasting time ; no one can tell how long the period of tolerance will last ; it may be but a few hours.

We will consider the case of a patient seen in the period of tolerance.

1. *Distend the bladder* with warm lotion, which stimulates the ureter to contract and occasionally results in the passage of a ureteric calculus.

2. *Radiography.* If facilities exist an X-ray is taken. In only three instances were stones demonstrable in a series of 7 cases of calculous anuria (Cahill and Gile). Gaseous distension of the intestine no doubt accounts for this surprisingly large percentage of negative X-ray findings.

3. *Cystoscopy* is performed. Occasionally a stone is seen wedged in a ureteric orifice, or œdema or a hæmorrhagic exudate on one side will indicate the side which requires immediate relief. The passage of ureteric catheters may possibly dislodge a calculus. If the catheter passes freely up the ureter, we at least know that obstruction must be near the kidney—a useful piece of information. If the findings are negative ureteric catheters should be left in position.

4. *Continuous intravenous saline and glucose* is given. If it has been possible to insert ureteric catheters these are left in position for the next two or three hours while preparations are made for operation. During this interval 1½ pints of saline and glucose are allowed to

gravitate into a vein. If this does not result in a copious flow of urine operation must be carried out forthwith.

5. *Deciding upon which side to operate.* A good rule is—select the side on which the patient last experienced pain. *Signe de Leguen*: Muscular resistance is greater over the kidney last to be obstructed. Such resistance is demonstrable on abdominal palpation.

If by radiography stones are located in the pelvis of each kidney, immediate nephrolithotomy is indicated.

If the stones are impacted in the ureters proper, it is as a rule wise to refrain from embarking upon what may prove to be a long and tedious operation, namely the extraction of a stone from the ureter. Rather, be content in a grave emergency with a rapid and certain method of treatment—to wit, nephrostomy.

Nephrostomy.—Gas and oxygen should be the anaesthetic used whenever possible. Expose the kidney in the loin. For this purpose the completely prone position offers two advantages. Firstly, the kidney can be cut down upon rapidly. Secondly, the opposite side is immediately available should the parenchyma of the first kidney be found to be inadequate. The ideal method of performing nephrostomy is to employ Cabot's technique (*Figs.* 304, 305). Instead of the type of malleable probe shown in the illustration I use an ordinary eyed silver probe which allows the silk to be attached easily. Cabot's method has the disadvantage that the kidney must be delivered and its pedicle displayed. When time is precious and the kidney large and difficult to bring on to the surface, recourse must be made to the following less refined method, which can be carried out if necessary in the wound without delivery of the organ.

Desperately Urgent Nephrostomy. Expose the convex border and sides of the kidney but be careful not to decapsulate it, and make a deep incision one inch in length transversely across the middle of the convex border, plunging the knife right in until it is judged, by the fingers of the left hand on the outside, that the point has reached the pelvis. The fingers of the left hand may be used to compress the renal pedicle, and this minimizes haemorrhage. Withdraw the knife, and immediately place a finger in the wound (*Fig.* 306). This will stop the haemorrhage, and, at the same time, make certain that the tunnel reaches the pelvis and is of an adequate size to admit a half-inch drainage tube, which is now introduced. The lips of the kidney wound are approximated by deeply placed sutures around the tube, as indicated in *Fig.* 305. Instructions are given to a nurse to deflate the air cushions which have been maintaining flexion of the trunk, and the wound in the loin is closed about the tube. An intravenous saline is one of the best diuretics, and may be conveniently administered before the patient leaves the theatre. A good flow

—MALLEABLE PROBE
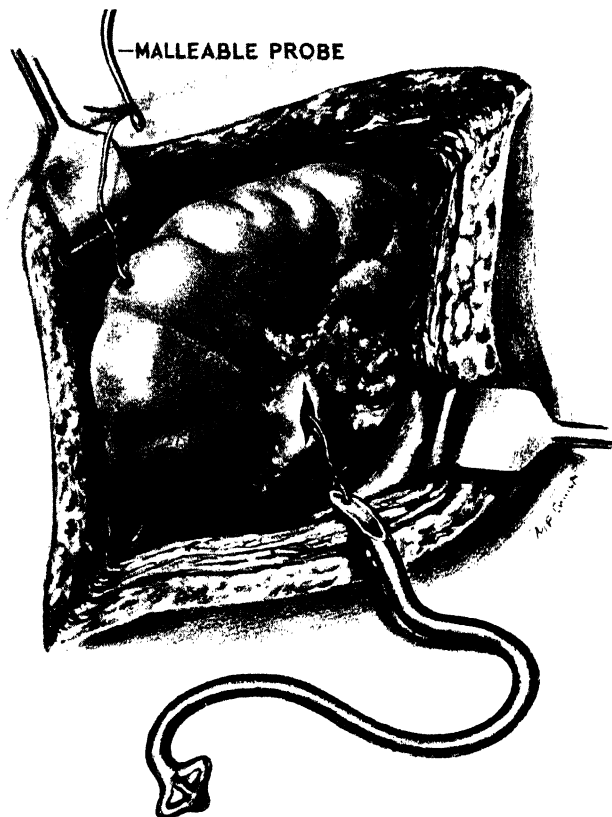
Fig. 304.   Cabot's method of performing nephrostomy.
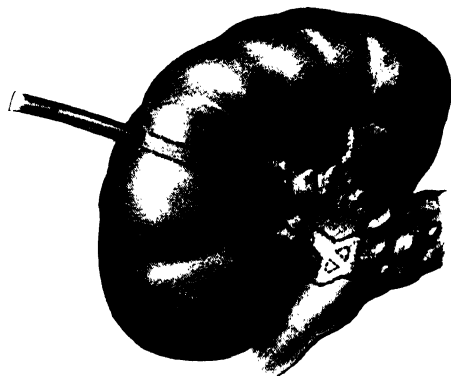
Fig. 305. —Cabot's method of performing nephrostomy completed.

of urine does not, as a rule, commence until twenty-four or forty-eight hours after operation. It is most important to be prepared for post-operative hæmorrhage, and it is a good practice in all cases to make full arrangements for blood transfusion, in case bleeding from the incised kidney becomes excessive.

Nephrostomy has lowered the mortality of calculous anuria from 71 per cent to 18 per cent (Jeanbrau).

FIG. 306.—Desperately urgent nephrostomy. This method can be used when it is difficult to bring the kidney on to the surface. The fingers of the left hand are compressing the renal pedicle whilst the index finger of the right hand makes sure that the tunnel has reached the renal pelvis.

Calculus obstructing the outflow of a single functioning kidney is also treated along the lines indicated above.

A woman of 45 had passed no urine for forty-eight hours. A catheter was introduced, but not a drop of urine was withdrawn. Four years previously her right kidney had been removed for calculous pyonephrosis. She was now in violent pain in her left side. She was extremely obese, and an X-ray was not helpful.

The bladder was distended with lotion when the patient gave a piercing shriek followed by a sigh of relief. A calculus about the size of a date stone was discharged.

The same patient was readmitted one year later. This time she had passed no urine for nearly three days. The bladder was empty. Vesical distension was of no avail, so the patient was anæsthetized. By cystoscopy, a ureteric catheter was passed freely up the left ureter, which indicated that the obstruction was near the pelvis of the kidney. The

kidney was now exposed in the loin. Owing to the great obesity of the patient it was necessary to resect the last rib before the organ could be displayed. A calculus was felt in the first inch of the ureter. This was pushed up into the renal pelvis with the finger. Nephrostomy was performed. Owing to the friability of the œdematous kidney, sutures on either side of the tube cut out, but this difficulty was overcome and the resulting hæmorrhage checked by inserting fresh sutures over a muscle graft taken from the erector spinæ. After the wound had been closed an intravenous saline was given as a diuretic. Recovery. Eighteen months later she was quite well. She wears a nephrostomy belt (*Fig.* 307) which is efficient.
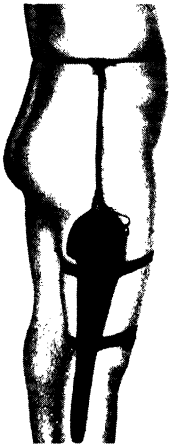
Fig. 307. Permanent nephrostomy. The nephrostomy tube is kept in place by a string around the waist. This simple apparatus is efficient, particularly when nephrostomy has been performed by Cabot's method. (*After M. L. Boyd.*)

Anuria from Double Hydronephrosis. Almost always the cause of this condition is carcinoma of the cervix invading the ureters. The prognosis is usually exceedingly poor. In 3 cases which I have been called upon to treat, the patients survived but a few hours. The only immediate treatment possible is unilateral or bilateral nephrostomy.

Anuria due to a Reno-renal Reflex. Some deny the existence of this phenomenon, others have seen undoubted cases. When other measures fail Rubritius has found decapsulation is effective.

RENAL DECAPSULATION

Opinions on this method are sharply divided. The surgeon has but little opportunity of selecting his cases, and not infrequently he is asked to operate as a last resort. A patient in an advanced stage of uræmia with air hunger and a urea frost upon his œdematous skin is very unlikely to respond to surgical or for that matter any other form of treatment. On the other hand, a case of acute or subacute parenchymatous nephritis, in which uræmia is *threatened*, may be very distinctly benefited by Edebohl's operation. In cases of acute nephritis with rapidly oncoming oliguria or anuria Continental surgeons speak highly of renal decapsulation, if performed within twenty-four hours of failure of the kidneys to respond to stimulation by medical means.

Gas and oxygen is the anæsthetic indicated in uræmic conditions. The completely prone position over an air cushion gives ready access to both kidneys. An incision is made in the loin. There is no need to deliver the kidney: shock is thus minimized, and a long step taken

towards rapidly completing the operation. The capsule is incised along the whole of the convex border. The cut edges are picked up and the capsule peeled on each side towards the hilum (*Fig.* 398). The incision in the loin is closed with drainage a small drainage tube usually sufficing. The operation is repeated on the opposite side if the anaesthetist reports favourably on the patient's general condition.
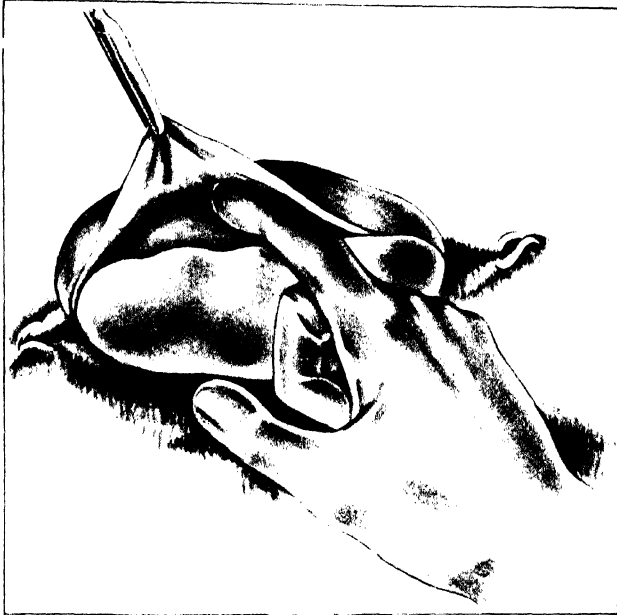
98. Renal decapsulation. The capsu
In urgent cases it is not necessary to

RUPTURE OF A HYDRONEPHROSIS

H. W. L. Molesworth records the following case : —

A woman of 50 fell from a chair and struck her left side. Violent abdominal pain followed, and shortly afterwards she vomited. When examined, abdominal rigidity was marked, especially on the left side. Under general anaesthesia an abdominal tumour was apparent. The abdomen was opened, and a large retroperitoneal swelling was found. A ruptured hydronephrosis was removed by the lumbar route. Recovery.

Coincident tearing of the peritoneum has been noted in 25 per cent of cases of ruptured hydronephrosis. This favours a preliminary

laparotomy, which has the advantage of enabling one to determine the condition of the opposite kidney. If the hydronephrosis has ruptured into the peritoneum, abdominal nephrectomy should be undertaken. If, however, the fluid mass is extraperitoneal, the abdominal wound should be closed, and the kidney removed by the lumbar route. When the kidney of the opposite side is diseased, and the wall of the hydronephrosis contains even a small amount of kidney substance, an endeavour should be made to save the organ by stitching it up around a drainage tube.

MANAGEMENT AND TREATMENT OF RENAL INJURIES

GENERAL INDICATIONS

'**Slight**' **Injuries.**—Even when there are no general and local signs, all patients with hæmaturia following an accident should be put to bed and kept there until one week after all macroscopical
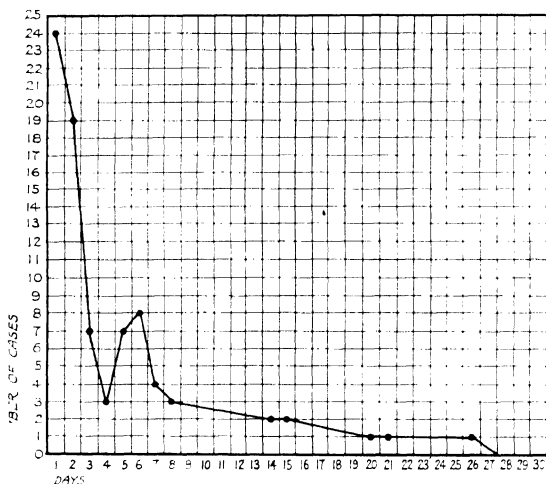
Fig. 309.— Graph showing the duration of hæmaturia in cases of renal inju treated expectantly.

evidence of blood in the urine has disappeared. A urinary antiseptic is administered to prevent the supervention of infection. *Fig.* 309 shows the duration in days of hæmaturia in a series of 'slight' injuries to the kidney treated expectantly. Before discharging the patient it is most desirable to visualize the renal tract by excretion pyelography.

Recording the Pulse-Rate.—The pulse-rate should be recorded hourly. In cases which respond to expectant treatment the frequent

pulse-reading must be continued over a longer period than the patient's general condition seems to justify, for signs of extensive laceration may be considerably delayed.

A male, aged 18, was kicked in the right loin by a horse. On admission, pulse 86, temperature 97·8 . There was no sign of external injury or

Ruptured kidney following a kick from a horse—anæmic
infarction of lower pole.

swelling in the loin. Considerable tenderness of right side of abdomen was present, also rigidity of upper right rectus. The urine contained blood. Slight hæmaturia continued for five days. During this time the rigidity persisted and the patient complained of pain in the right side. Pulse remained full and slow. Suddenly, at 1.30 p.m. on the sixth day there was a torrential hæmaturia. The lad became collapsed. After morphia and posture had improved the general condition, a lacerated kidney was extirpated (*Fig.* 310). Recovery.

Excretion Pyelography.—When facilities exist, the question of having an excretion pyelogram will arise. In the type of case just quoted, i.e., where the patient is apparently progressing favourably, the information gained by visualization of the renal tract about the

fourth day of the accident may prove to be invaluable in forestalling unexpected torrential hæmorrhage. Within forty-eight hours of the injury it is my experience that it is better to *depend solely upon clinical signs.* Conversely, having decided to operate, providing the condition of the patient is not desperate, an excretion pyelogram will provide concrete evidence of a functioning kidney on the opposite side—an assurance which saves time and limits manipulation upon the operating table.

Severe Injuries.—

General Rest.—Once a diagnosis has been made, morphia is administered, and repeated as necessary.

Local Rest. A towel having been laid across the abdomen, sandbags are placed on either side of the patient. This prevents movement effectively, but it allows examination of the region, which is so necessary. An ice-bag is a valuable placebo, and helps to keep the patient still (*Fig.* 312).

Saving Specimens of Urine for Inspection. In all cases the urine should be saved and placed in glasses bearing a label indicating the time of voiding. It is then possible to compare one sample of urine with a later specimen, and thus to estimate whether the external
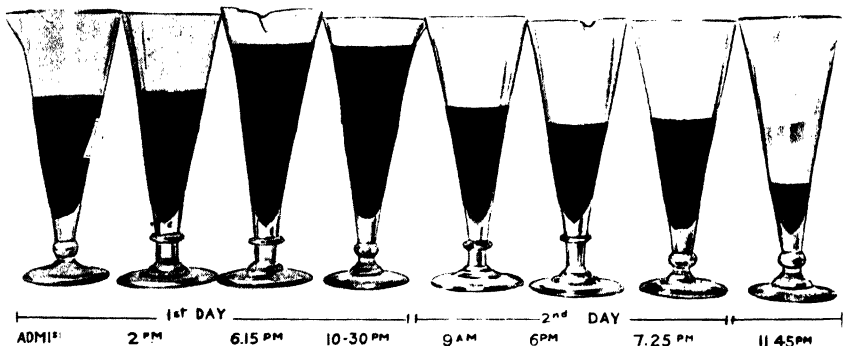
Fig. 311.—Injury to the kidney. The urine is saved, and placed in glasses labelled with the time of passing. In this way one sample of urine may be compared with a later specimen, and an estimation can be formed as to whether the bleeding is progressive or not. In this case the hæmorrhage, which was at first severe, abated after thirty-four hours, and the patient recovered with expectant treatment.

bleeding is progressive or not (*Fig.* 311). In comparing two samples —especially in an artificial light—it is often helpful to dip a strip of white blotting paper into each specimen after stirring. For purposes of comparison, the concentration of blood in the urine is seen more

readily in the absorbent paper. The presence of clots in one sample would of course vitiate the result.
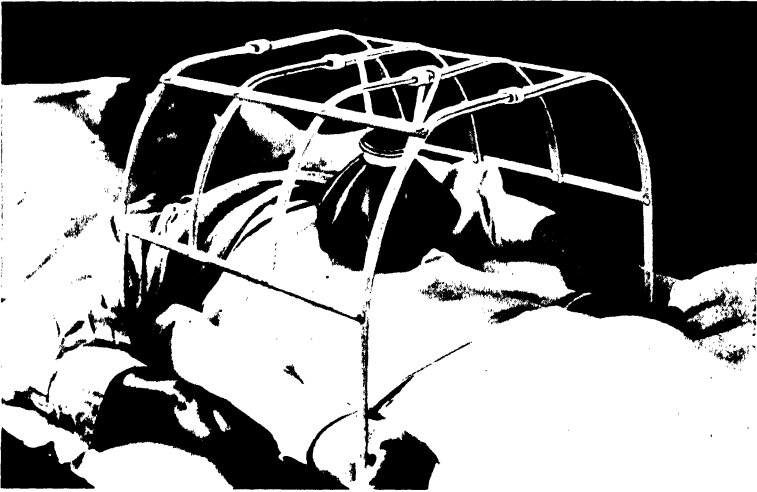
Fig. 312. Injury to the kidney. Method of keeping the patient at rest. The cloth-and-sandbag method allows periodic inspection of the abdomen. An ice-bag helps to keep the patient still.

The Diagnosis of Ruptured Kidney has been Made, but is there an Intraperitoneal Lesion also ?

First let it be emphasized that within twenty-four hours, or even less, of a severe injury to the kidney *considerable meteorism* is usual. This is due to bruising of the colon overlying the kidney. On several occasions I have verified that it is ballooned colon, as opposed to small intestine, which gives rise to this diagnostically confusing distension. When this is taken into account the situation is often simplified. If it is considered wise to explore the abdomen under these conditions I suggest it is wise to use a comparatively small incision. Having ascertained that there is not an undue amount of free fluid in the peritoneal cavity and having verified the presence of a bulging hæmatoma in one loin and a normal kidney in the other, much the best course is to close the laparotomy incision and explore the kidney from the back. Abdominal nephrectomy in the presence of even moderate meteorism is a herculean task.

A well-developed youth was knocked off his bicycle. He arrived in hospital in a shocked condition complaining of severe left-sided abdominal pain. The first specimen of urine was full of bright red blood, but subsequently he passed almost clear urine several times. During the night his pulse-rate rose from 90 to 125. When I saw him he was obviously anæmic.

The abdomen was distended and shifting dullness could be elicited. The abdomen was opened through a limited mid-line upper abdominal incision. Clear but considerably blood-stained fluid ran out. The spleen and liver were intact ; the palpating hand readily made out a large retro-peritoneal hæmatoma on the left side. The right kidney was present. A suprapubic drainage tube was inserted, and the abdominal incision was speedily closed. Turning the patient over, the left kidney surrounded by blood-clot, blood, and urine was exposed. The renal pelvis was torn almost completely across ; indeed, the kidney was practically avulsed from its pedicle. Nephrectomy was done (*Fig.* 313). The perirenal space was packed with gauze, the first portion moistened with turpentine. The patient was now pulseless and no time was lost in giving him a blood transfusion, for matched blood was in readiness. The gauze packs were removed on the 4th day uneventfully. Convalescence was smooth, the only complication being some suppuration in the renal wound. I feel sure that, at any rate in my hands this patient would not have recovered if *abdominal* nephrectomy had been attempted.

Fig. 313. The specimen ta from the patient referred to in text. The kidney was practically avulsed except for vessels enter the upper part of the pedicle (X).

The Diagnosis is Doubtful. Although the Kidney is Damaged it seems probable that an Intraperitoneal Organ is Ruptured in addition.

No question arises as to the correct procedure. The abdomen must be opened. Again, in the first place, the incision can be kept comparatively small. If the spleen is found to be ruptured it is removed. It is in dual lesions when the abdomen has been opened before considerable intestinal distension has arisen that abdominal nephrectomy (p. 328) is to be recommended unhesitatingly. Severe injuries to more than one organ are so fatal that it is encouraging to learn that in one dual catastrophe there is at least hope. Of 46 cases of concomitant rupture of the spleen and the left kidney collected by Desjacques and treated by combined nephrectomy and splenectomy, nearly 50 per cent recovered.

The Diagnosis of Ruptured Kidney has been Made.---

Indications for Exploration (for technique, *see* p. 323). —

1. The immediate hæmorrhage is severe enough to endanger the patient's life.

2. The hourly pulse-reading is rising steadily.

3. Severe secondary hæmaturia.

4. Continued moderate hæmaturia over many days.

5. The excretion pyelogram shows considerable renal damage.

As in other cases of severe hæmorrhage blood transfusion is often advisable and in the case of a ruptured kidney there is usually sufficient time to carry out this step before the operation.

In 99 cases out of 100 when a kidney is the only organ damaged the rupture is entirely extraperitoneal. It is for this reason that I consider *lumbar* exploration desirable.

Determining the Presence of the Other Kidney.— While only one individual in 1500 has congenital absence of one kidney, it should be the rule in injuries to the kidney to ascertain the presence of a second organ. It is rarely permissible to neglect this step, as the following unfortunate coincidence emphasizes.

A patient, having been gored in the loin by a bull, was rushed to a hospital in the nearby city. His lacerated kidney was removed promptly, but he passed no urine, although he survived for several days. Necropsy showed that the only functional organ had been excised. A few months later, into the same hospital was admitted a second patient who had been gored by a bull. It was found that the kidney had been wounded, and it was removed. He, too, passed never a drop of urine, and the post-mortem revealed that the contralateral organ was congenitally absent.

Methods of satisfying oneself that there is a healthy kidney on the opposite side are as follows :

1. Excretion pyelography.

2. Palpation under anæsthesia— this method is frequently unsatisfactory.

3. Cystoscopy combined with injection of indigo-carmine—time-consuming, for the bladder has usually to be washed out before anything can be seen satisfactorily. This excellent method is not available in urgent cases of severe hæmorrhage.

4. Opening the peritoneum in the ventral portion of the lumbar incision, and trans-abdominal intraperitoneal palpation. The hole in the peritoneum is subsequently sutured.

Indications for Nephrectomy (for technique, see p. 325 et seq.) —

1. The renal pedicle is torn.

2. The kidney is lacerated in several places.

3. There is a tear extending towards the renal pelvis, but the kidney has a short pedicle and cannot be completely delivered ; it is impossible to suture a rent which cannot be displayed.

4. There is an extensive rent in the renal pelvis (which cannot be sutured), or the ureter is completely avulsed.

5. The injured kidney is hydronephrotic or otherwise severely diseased.

Nephrectomy is necessary in the majority of those cases severe

enough to merit urgent exploration. Exceptionally, when the injury is confined to one pole *partial nephrectomy* can be carried out (*see Fig. 314*). When faced with the dilemma of serious damage to an only functional kidney, suture combined with packing with gauze, followed by a blood transfusion, if necessary repeated, is all that can be done.

Fig. 314.—Ruptured kidney from a run-over accident.

Suture.—Suture of a ruptured kidney is only indicated occasionally. At first sight this statement appears undesirable, for of course every effort should be made to save a potentially functional organ. Further consideration will make it clear that we select only patients with *severe* damage to the kidney for exploration. Consequently, but few kidneys with comparatively small rents, i.e., those suitable for suture, are exposed to the light of day ; they heal under expectant treatment. When suture is possible the following technique will be found efficient. Seeing that muscle is always available around a lumbar incision, this method (*Fig.* 315) of suturing a rent of the parenchyma is most satisfactory : —

A deep mattress suture is passed first—a round-bodied curved needle is used —the blunt end of the needle penetrating the renal substance first. The ends of the sutures are left untied and secured with a hæmostat.

Interrupted sutures are passed deeply, but nearer the edges of the laceration.
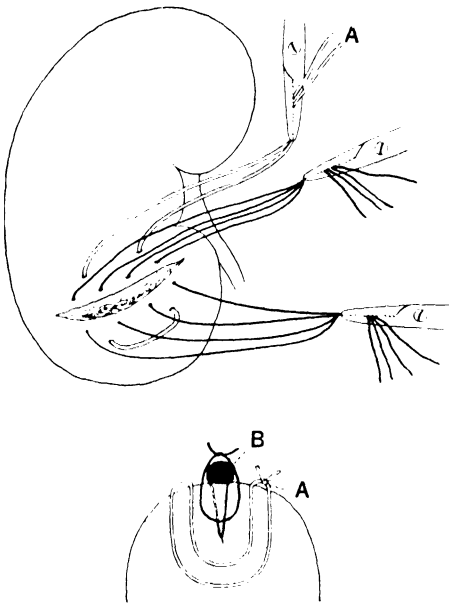
Fig. 315. Method of suturing a rupture of the kidney. A. Mattress suture, which is tied last ; B. Piece of muscle.
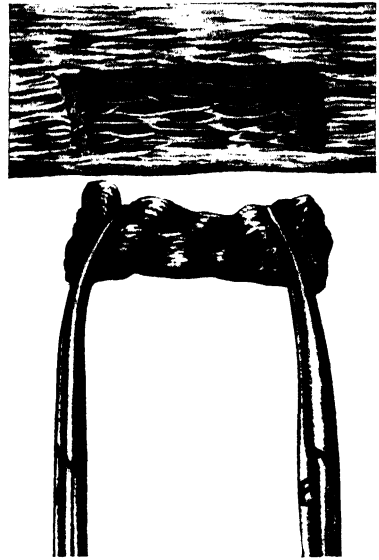
Fig. 316. A muscle graft taken from the erector spinæ. The forceps make an efficient ' spreader ' whilst the muscle is being transferred to the kidney and sutured into position.

A piece of muscle (*Fig.* 316) is placed over the rupture, and the interrupted sutures are tied over it. Finally, the mattress suture is tied.

The advantages of this method are that the sutures do not cut out ; the muscle, being rich in thrombokinase, favours clotting ; and the rent is plugged with Nature's own material.

TRAUMATIC PERIRENAL HÆMATOMA

Here we are confronted with a less anxious problem. Nevertheless, it must not be forgotten that although the external bleeding is slight, occasionally delayed sudden alarming hæmaturia ensues (p. 337). For the moment the patient should be watched carefully and kept strictly at rest. Although there is no immediate hurry,

it is better to drain a large perirenal hæmatoma, for these collections of blood (*Fig.* 317) are particularly liable to become infected ; moreover, even should they resolve—a slow process –further trouble is not necessarily at an end. I have met with a case where the contracture of a resolving perirenal hæmatoma literally strangulated the kidney within it.

Fig. 317. –Perirenal hæma toma. (*Papin.*)

Drainage of a Perirenal Hæmatoma. The extravasated blood tends to track along the psoas muscle towards the iliac fossa.

If on abdominal palpation under the anæsthetic the swelling is found to be invading the iliac fossa (as it usually is), a gridiron incision is made as for appendicectomy. When the peritoneum is reached, it is pushed medially and the retroperitoneal tissue then opened up with the finger. A tube is passed upwards towards the kidney. The patient is nursed in a sitting position. The infected extravasated blood is drained from its lowest point with minimal disturbance to the kidney, which, by the time the hæmatoma has become infected, is most probably in a stage of repair.

When the swelling is mainly in the loin the hæmatoma can be drained by the posterior route, precisely as a perinephric abscess is evacuated. (See also Rupture of the Ureter, p. 347.)

SPONTANEOUS PERIRENAL HÆMATOMA.

One hundred and seventy cases of this curious condition have been reported (Heritage). The classical triad of abdominal pain, signs of internal hæmorrhage, and a swelling in the loin, are often obscured by the resemblance to an acute abdominal catastrophe. There is not a single underlying cause some cases are due to bursting of an aneurysm of the renal artery, others are caused by renal neoplasms or inflammation, still others are probably due to obstruction to the renal veins. Without operation the condition is said to be always fatal. The largest proportion of recoveries have followed urgent nephrectomy, and it is advised to carry out this step in most cases. When the patient will not stand removal of the kidney, or the organ and its pedicle appear to be quite normal, recourse will be made to packing.

PYONEPHROSIS

Pyonephrosis is not, as a rule, a very urgent condition. Nevertheless the kidney should be drained as soon as the diagnosis can be established. Cystoscopy after an intravenous injection of indigo-

carmine will help in arriving at the correct diagnosis. Those cases of pyonephrosis which are operated upon during the first few days usually recover; whilst those in which the treatment is delayed (usually because of difficulty in diagnosis) frequently die in spite of operation. In nearly all cases it is simple nephrostomy and not nephrectomy which should be performed in the first instance. A large tube is inserted into the centre of the pus sac through the convex border of the kidney (*Fig. 318*). A soft rubber drain is also inserted into the perirenal space. Unless the cause of the obstruction can be removed at the time of the operation e.g., a stone dislodged from the pelvis of the kidney further operation will be necessary later on; otherwise the pyonephrosis will recur, or permanent renal fistula result. One of my patients, in whom nephrectomy was contra-indicated on account of enormous obesity and mitral stenosis, returned three times at intervals of about six months with a recurrent pyonephrosis which was drained in each instance.
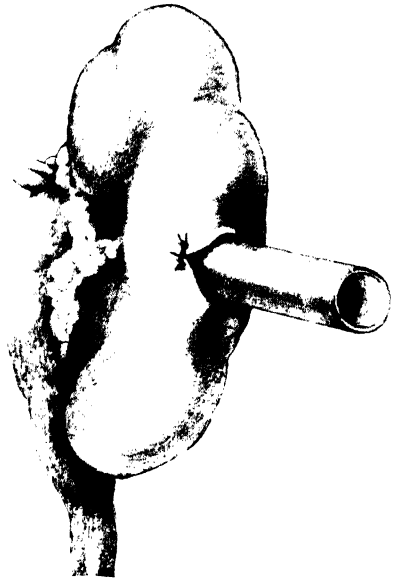
Fig. 318.   Drainage of a pyonephrosis.

PERINEPHRIC ABSCESS

The term perinephric abscess as commonly used probably embraces a number of different conditions in which the abscess is but an important incident. There is, however, a clinical entity 'perinephric abscess'. Here the perinephric fat appears to be attacked primarily by a blood-stream infection. Bacteriological examination frequently shows *Staphylococcus aureus*. If the abscess is pointing, there is little more to be done than an incision and the insertion of a tube. It is a good practice to examine the kidney at the same time. In one of my cases there was merely a shell of kidney substance containing caseous matter, so nephrectomy was performed; but this is most exceptional.

When the pus is not near the surface, the abscess is approached by the usual incision to expose the kidney.

The diagnosis of perinephric abscess is often most difficult. In

43 cases the diagnosis was not made for (on an average) five weeks (Habein). *One should not wait for fluctuation, but explore as soon as the condition is strongly suspected.*

CARBUNCLE OF THE KIDNEY

The diagnosis of renal carbuncle is often even more difficult than that of perinephric abscess, for which the condition is often mistaken, and with which it is occasionally associated. There is sometimes a primary focus on the skin, usually a carbuncle or furuncle. Like cases of perinephric abscess, the leading feature is pyrexia. By a process of elimination and signs of tenderness in one loin the kidney is suspected. Sometimes pyelography is helpful in demonstrating the disease, but, curiously, pyuria is seldom in evidence, although staphylococci have been found in the urine from the affected kidney in a few instances. I have dealt with three cases of renal carbuncle. In the first two a diagnosis of perinephric abscess was made. On exploring the perirenal space no pus was found but the kidney was obviously enlarged, and when delivered showed multiple abscesses under the capsule especially towards the upper pole. In each of these cases an examination of the urine was negative. A distant focus of infection was discovered in only one of these patients, and that was a healing carbuncle of the neck. Nephrectomy was performed in each instance.

Fig. 319. —Carbuncle of the kidney.
(Dick.)

Two patients were almost moribund at the time of the operation, and one of these subsequently succumbed to a cerebral abscess and general pyæmia. The other two recovered and remained well.

In an ideal case—a patient in good condition with the carbuncle confined to one pole—the ideal treatment is partial nephrectomy.

STONE IN THE URETER.

The immediate treatment is that of renal colic (p. 320). While investigations are proceeding during the days which follow, a good antispasmodic, which is said to have a selective action on the ureter,

is ammi visnaga. The dosage recommended is as follows: 30 c.c. of a warm 1 40 decoction of ammi visnaga, together with 5 c.c. of 1 10 tincture of the drug, is given as one dose. Three doses, and occasionally four, are given each day.

Very exceptionally perforation of the ureter, or bursting of the dilated kidney pelvis above it, occurs.

P. B., aged 52, was admitted with acute abdominal pain and vomiting. The right side of the abdomen was rigid and the maximal tenderness was in the loin. He was diagnosed as renal colic, and next morning, after a dose of morphia and atropine, he appeared better. Three days later the temperature had risen to 103 F. and there was much tenderness and slight œdema in the loin. The kidney was therefore explored. The perinephric space was found filled with purulent urine, which was issuing from a perforation of the ureter immediately above an impacted ureteric calculus. The kidney did not appear to be hydronephrotic. Through a longitudinal incision the stone in the ureter was removed and the wound was drained. He developed a urinary fistula, which failed to heal after six months, during which time attacks of local suppuration and pocketing occurred. Eventually subcapsular nephrectomy was performed, and the patient has remained well.

URETERAL INJURIES.

Traumatic rupture of the ureter is very uncommon. Avulsion of the ureter proper from the pelvis of the kidney is the most usual variety. The lower third of the ureter has been wounded by a spicule of bone from a fracture of the pelvis. Rupture of the ureter often remains unrecognized until extravasation of urine into the deep planes of the loin arrests attention by causing a lumbar swelling. Perirenal extravasation of urine needs drainage. One is fortunate if, in the course of carrying this out, the point of leakage can be displayed: more often drainage is all that can be accomplished in the first instance.

If repair is possible, end-to-end anastomosis of the ureter (*see* p. 348) will be the most generally applicable.

Injuries to the Ureters during Hysterectomy and other Pelvic Operations. Injury to a ureter during the course of a difficult hysterectomy is more common than traumatic rupture. The accident could be minimized considerably by the preliminary passage of ureteric catheters. As a result of the operation accident the ureter is sectioned transversely or obliquely, or a piece may be removed from its side wall; it is sometimes occluded by a ligature, or ligation in its immediate neighbourhood causes an obstructive kink. Finally, an occasional complication after cautery operation for carcinoma of the cervix is necrosis of the juxta-cervical portion of the ureter which leads to a urinary fistula.

The site of the lesion is usually in the broad ligament near the

uterine artery (*see Fig.* 285), but it sometimes occurs somewhat higher. The injury may be recognized (1) at the time of the accident, (2) during the immediate post-operative period, or (3) later. We shall here refer to types (1) and (2).
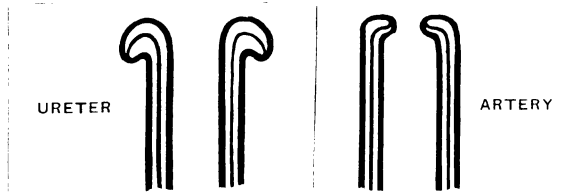
Fig. 320. The differential diagnosis between a cut ureter and a blood-vessel. The divided ureter pouts, whilst a divided artery retracts.

1. Injury Recognized at the Time of the Operation.—

It is highly important to perceive the divided ureter promptly and avoid being lulled into the belief that it is a vessel which has been clamped and severed. A divided ureter pouts, whilst a divided artery retracts (*Fig.* 320).

Having satisfied oneself that it is the ureter which is damaged, three courses are open, according to circumstances.

a. End-to-end anastomosis over a ureteric catheter is the best practice in most instances. A ureteric catheter is passed by cystoscopy. After the site of the rupture has been displayed, the lower end of the ureter containing the bougie is found easily. The upper end is then located. When the divided ends have been mobilized, anastomosis is carried out as shown in *Fig.* 321. After the suturing has been completed the line of junction may be reinforced by a strip of fascia.

b. Implantation into the bladder may be performed when a ureter is divided near its lower extremity. With the patient in Trendelenburg's position, an ample median incision is made. We proceed until the peritoneum is reached, but this structure is not opened. By gauze dissection the peritoneum is peeled off the fascia transversalis until the ureter, which adheres to the peritoneum, is reached. The end of the divided ureter is

URETERIC CATHETER

Fig. 321.—End-to-end anastomosis of a divided ureter over an indwelling ureteric catheter.

mobilized to avoid subsequent tension. A suprapubic cystotomy is performed, air distension of the bladder being advisable. The opening into the bladder is made larger than usual. The nose of a pair of haemostats is driven through all coats of the bladder from within outwards, at a point which will be convenient for the reception of the ureter. The free end of the ureter is seized by the forceps and drawn into the bladder. It is then sutured as depicted in *Fig. 322*, and the redundant ureter is cut off obliquely. Sutures are inserted on the outside in a circular manner, exactly as was done on the inside. Thus the junction is maintained by a double row of sutures. The bladder is closed with drainage.

c. Abdominal Nephrectomy. - I have, on two occasions, been summoned to the operating theatre to perform abdominal nephrectomy when the gynæcologist thought it unwise to attempt ureteric anastomosis. In one of these cases the kidney, the ureter of which had been divided, was hydronephrotic.

2. Injury Recognized during the Immediate Post-operative Period.

a. Anuria after hysterectomy usually means that both ureters have been ligated. The correct treatment is bilateral nephrostomy. To attempt to

Fig. 322. Transplantation of a ureter into the bladder. The nose of the forceps is thrust through all coats of the bladder from within outwards. The end of the ureter is drawn through the puncture as shown. Sutures are then applied both on the outside and inside, as indicated. The end of the ureter which is hanging into the bladder is cut off obliquely with scissors.

explore the abdomen at this stage, when structures are œdematous and matted, combined with the uncertainty of finding the occluded ureter, is to court disaster. Nephrostomy (p. 331) is a certain method : when the patient is out of immediate danger is time enough to attend to the actual lesion.

R. V. Day's Case. -

A woman of 28 was seen four days after an operation for hysterectomy. She had passed no urine since the operation, and the bladder was empty. Day performed bilateral nephrostomy. Two months later the left ureter

was transplanted into the bladder. It was found that the right ureter had
been sectioned too high for an anastomosis with the bladder, so nephrectomy
was performed on that side. The patient made a good recovery.

J. R. Caulk's Case.

Both ureters had been ligated in the course of a hysterectomy. Caulk
performed bilateral nephrostomy eight days after the operation. On the
fifty-eighth day both nephrostomy wounds closed, the urine coming nor-
mally from both kidneys. Five years later this patient was seen, and had
been perfectly well in the interval.

This, undoubtedly, was a case where the ureters had been ligated
with catgut, which absorbed ultimately.

b. Urinary fistula following accidental wounds of the ureter
during pelvic operations are usually external ; the leak occurs through
the abdominal wound or the vagina. Hunner and Everett refer to
urinary ascites. In their case the peritoneal cavity became filled
with urine for more than a week. It is interesting to note that the
patient was not gravely ill. She was treated satisfactorily by implanting
the proximal end of the cut ureter into the bladder, and she remained
well. Each case of urinary fistula following severing of the ureter
must be treated on its merits. It is not advisable to attempt implant-
ing the ureter into the bladder for several weeks. An excretion pyelo-
gram is helpful in acquiring necessary data. I implanted successfully
the left ureter into the bladder four weeks after I had cut it during
a perineal excision of the rectum.

If nephrectomy is considered the wisest course it may be under-
taken earlier than a plastic operation.

Nephro-ureteral anastomosis.— A rare, but disconcerting, accident
during a renal operation is avulsion of the ureter.

A cellarman, aged 53, was admitted with calculous anuria. During the
three days immediately preceding admission he had been in violent pain
and had passed only a cupful of urine. An X-ray showed bilateral renal
calculi, and as the pain was last experienced on the left side, it was decided
to explore the left kidney. The organ was displayed and partially delivered,
for the pedicle was short. A large calculus could be felt occupying the
pelvis of the kidney. Spikes from the calculus (it was an oxalate) could
be seen and felt projecting on the surface of the thinned renal pelvis. An
incision was made over the stone, and an attempt made to deliver it.
Whilst endeavouring to dislodge the calculus, the pelvis suddenly became
detached from the kidney, and the ureter was seen limply attached to the
kidney by a shred of tissue. The stone was now easily removed, but the
problem to be faced was the repair of the damage. Nephrectomy could
not be considered. With very little hope of obtaining a functional anasto-
mosis, but with the thought that even a renal fistula would tide the patient
over the crisis, the following procedure was adopted.

The small transverse incision in the hilum was extended towards the
convex border (*Fig. 323a*). The torn edge of the pelvis was sutured at
first to the lower (*Fig. 323b*) and then to the upper (*Fig. 323c*) lips of the

wound. The whole suture line was then reinforced by superimposed muscle graft (*Fig.* 323*d*). The kidney was now replaced and the lumbar incision closed with drainage. The discharge of urine from the wound ceased on the eighteenth day. Six weeks later a large calculus was uneventfully removed from the right kidney.

Two-and-a-half years later the patient was seen in good health, but cystoscopy, etc., showed that the left kidney was barely functioning.
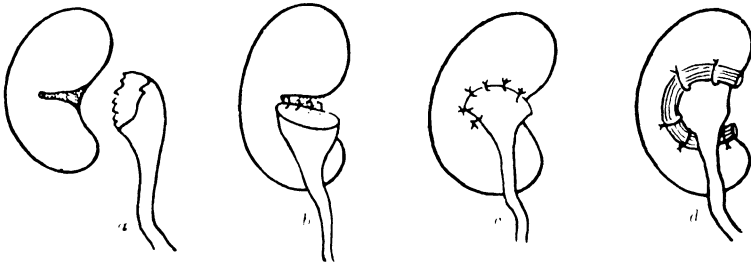
Fig. 323. Repair of renal pelvis after avulsion of ureter.

Campbell Begg has described an operation for nephro-ureteric anastomosis rendered necessary by an accident similar to that recorded above. He dealt with the situation in a manner which is, I think, in many respects superior to mine. A No. 6 French catheter was passed butt-end first down the ureter. The eye of the catheter was passed into the renal pelvis. The upper end of the ureter was split, and, by means of stitches, was so fixed that the margins were approximated roughly to the frayed renal pelvis. A capsular flap was now turned down to cover and reinforce the suture line. Nephrostomy was then performed. Subsequently the catheter was removed from the bladder by an operating cystoscope. The patient recovered. In a supplementary report published later Campbell Begg states that the patient developed pyonephrosis, and eventually nephrectomy had to be performed.

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CHAPTER XXIV

THE BLADDER, PROSTATE, AND SEMINAL VESICLES

RUPTURE OF THE BLADDER

" No case of rupture of the bladder ever recovers," the despairing cry handed down from the Ancients, was first disproved in 1859 by Dr. Walther, of Pittsburg. This courageous practitioner, defying his consultants, opened the abdomen of a young blacksmith ten hours after an accident. The enterprise was crowned with success.

Except in utter smashes and perforation by fragments of bone, traumatic rupture is practically impossible unless the bladder is full. It will be appreciated that in an inebriated individual the bladder is likely to be distended and the abdominal musculature off its guard; thus, if an abdominal contusion comes their way, intoxicated persons are candidates *par excellence* for this catastrophe.

Traumatic rupture of the bladder is supremely and only remediable by operation, but the operation must be undertaken reasonably early. Herein lies the difficulty. The condition is rare, and, particularly in intraperitoneal rupture (cf. *Figs.* 324, 325), initial symptoms may be trivial. Most of us can recall cases where a beguiled clinician,
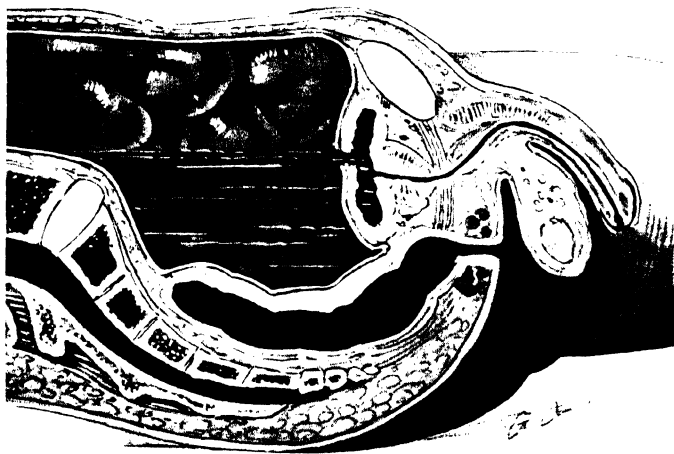
Fig. 324. Intraperitoneal rupture of the bladder.

having reassured and sent the patient home, is later thunderstruck
at the necropsy findings. Every large series of cases shows a high
mortality. Doubtless this could be reduced if the profession made it
an unwavering rule to keep a patient who has had an abdominal
contusion under constant observation until he has passed an adequate
amount of normal urine. Statistics show that when operation is
performed within twelve hours the mortality is 11 per cent; when
operation is delayed to twenty-four hours it is 55 per cent. Without
operation, as in the days of ancient Greece, it is 100 per cent.
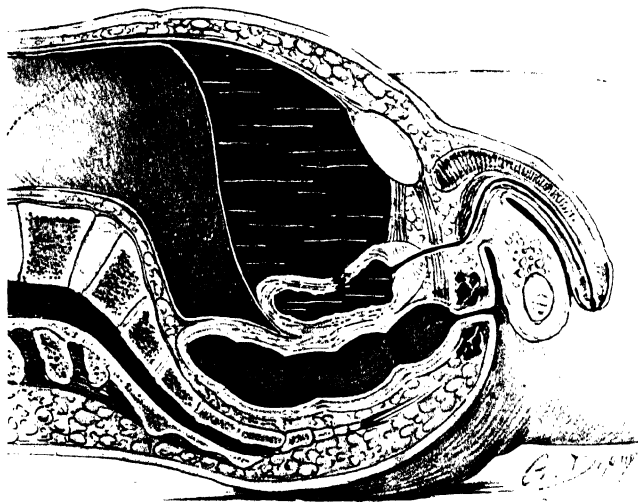
Fig. 325.—Extraperitoneal rupture of the bladder. The
or practically so. (Cf. *Fig.* 324.)

Means of Confirming a Suspected Diagnosis. These are supremely
important, and, according to the facilities available, will be one of
the following :—

Method 1.—*Excretion urography.* If X-ray pictures are taken
seven and eight minutes after an intravenous injection of uroselectan
B an absolute diagnosis is sometimes possible (*Fig.* 326) without the
need of passing a catheter. This is an ideal method.

Method 2.—Preferably in the operating theatre, a catheter is
passed. A little blood-stained urine is recovered, or perhaps pure
blood. *Place the patient in Fowler's position* and introduce 12 oz. of
sterile normal saline into the bladder. If all, or almost all, the fluid
is not returned the diagnosis of rupture is confirmed. While running
in the fluid it is important to keep the patient in Fowler's position,
for reasons which should be obvious.

If the diagnosis is still doubtful, the bladder can be filled with 2 per cent sodium iodide solution prior to cystography, but in my view this is a waste of time; there is sufficient evidence to warrant an exploratory operation.

Fig. 326.   Excretion pyelogram showing rupture of the bladder.   (*E. G. Mark.*)

Methods not to Employ.

Cystoscopy is generally useless.   If the tear is a large one, the bladder cannot be distended.   If there is a small puncture and bleeding does not obscure the view, who can tell if it extends through the muscle coats?

The introduction of air down the catheter (whether for purposes of attempting to obtain a pneumocystogram or to see if the liver dullness becomes obliterated) is not recommended.   Shock, peritonitis, and air embolus are possible complications.

INTRAPERITONEAL RUPTURE OF THE BLADDER

The rupture is intraperitoneal in 80 per cent of cases, and the tear is usually situated on the posterior aspect of the dome of the bladder.

Operation. Make a fairly liberal subumbilical, paramedian incision.   Carry the incision right down to the pubic bone.   Open the peritoneum and mop up the urine.   Have the table tilted slightly downward by the head, and pack off the intestine so as to leave the pelvis clear.

By gauze dissection strip the peritoneum off the antero-superior surface of the bladder and thus open up freely the cave of Retzius. Make an incision into the bladder as for suprapubic cystotomy (*see Fig. 333*).   Introduce a finger into the bladder.   With the left index finger in the bladder the interior can be explored thoroughly and the rupture

or ruptures usually will be found. If the rupture is on the posterior
wall or in any part of the dome, with the finger in the bladder as
a retractor, this portion can be brought into view. It will now be
found convenient to change from the right side of the patient to
the left, the better to stitch the bladder. As speedily as possible the
rent should be closed with interrupted sutures penetrating deeply the
bladder musculature (*Fig.* 327). It is unnecessary and a waste of time
to attempt to close the rent layer by layer, or to employ any form of
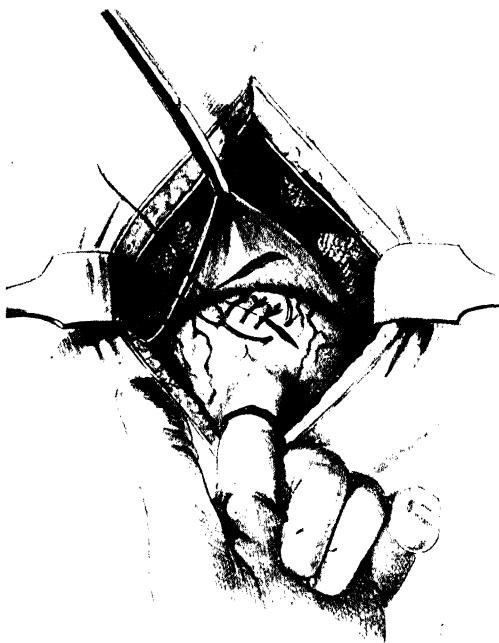
Fig. 327. —Suturing an intraperitoneal rupture of the bladder. The peri-
toneum has been stripped off the organ. Note the finger in the suprapubic bladder
incision raising the empty bladder from the depths of the pelvis.

fancy suturing. *Of the greatest importance in the entire surgical procedure
is the establishment of liberal suprapubic bladder drainage.* Once the
rent has been closed, a $\frac{3}{4}$-in. drainage tube is passed into the supra-
pubic bladder incision and the bladder closed snugly around it. With
such free drainage bleeding and extravasation will cease, and small
unsutured bladder wounds heal. The packing is now removed from
the abdomen and the table levelled.

Unless there is frank peritonitis, after again mopping up any fluid
which may be present, the peritoneal cavity can be closed completely;

otherwise a suprapubic peritoneal drain is left in position. It is
always advisable to leave a strip of corrugated rubber to drain the
cave of Retzius.

Fig. 328.   Cathcart's siphon evacuator at work.   This is an excellent method
    of keeping the bladder empty after repairing a rupture of the organ.

As soon as the patient recovers from shock, he is nursed in
Fowler's position. When possible, some form of suction apparatus
(*Fig.* 328) is used in order to keep the bladder as empty as possible
during the process of healing.

EXTRAPERITONEAL RUPTURE OF THE BLADDER

Extraperitoneal rupture occurs in 20 per cent of cases, and is,
almost without exception, a complication of a fractured pelvis. The
difficulties of distinguishing between an extraperitoneal rupture of
the bladder and an intrapelvic rupture of the urethra are referred to
on p. 395.   If the rupture is entirely extraperitoneal, it is necessary
only to perform suprapubic cystotomy and to drain the cave of Retzius.
If the rupture happens to be on the anterior wall, the drainage tube
can be inserted through the rent and the bladder closed around the

tube.   If it is not so conveniently placed, and by the exploring finger
in the bladder the rent is found to be a large one, it may be closed
by interrupted sutures applied by the transvesical method.   But this
is not necessary; indeed, it is to be disparaged, for with dual drain-
age of the bladder and the prevesical space the rent will heal, whereas
if sutures are introduced, unless care is taken, it is possible to include
a ureter in a stitch.

Before completing an operation for extraperitoneal rupture an
assistant should pass a catheter from the external meatus : by seeing
and palpating the beak of the catheter within the bladder, we are
assured that the whole course of the urethra is intact.

INTRA-EXTRA-PERITONEAL RUPTURES

In ruptures which involve both the intra-and the extraperitoneal
portions of the bladder, the procedure is exactly the same as for an
entirely intraperitoneal lesion.

INJURY TO THE BLADDER COMMITTED BUT RECOGNIZED DURING OPERATION

This error is most easily committed when performing *suprapubic
drainage of the peritoneum*.   It is of course almost impossible if, as is
usually the case, one hand can be introduced through a laparotomy
incision to act as a guide.   But if suprapubic peritoneal drainage is
being performed *per primam*, such as would be the case in a collection
of pus occurring some days after the appendix had been removed,
the danger is a very real one.   To have the patient catheterized
before he comes to the theatre is insufficient   I know this to my
sorrow.   The bladder must be emptied *after the patient has been
anæsthetized*.

Femoral herniotomy, particularly when the low operation was in
general use, proved to be a source of injury to the bladder.   Before
operating upon a strangulated femoral hernia, the bladder should be
emptied by passing a catheter after the patient has been anæsthetized.
This is the only way of being absolutely certain that the organ is empty.

Fig. 329. Self-retaining catheter.

If the bladder has been opened inadvertently, it should be closed
by two layers of sutures.   During the after-treatment urinary anti-
septics are administered freely, and catheterization is carried out
regularly for a week, in order to lessen the tension upon the suture line.
For the first forty-eight hours it is advisable to employ a self-retaining
catheter (*Fig.* 329).

Other causes of rupture of the bladder: (1) As a complication of difficult labour; (2) After forcible irrigation or catheterization of a pathological bladder; (3) During litholapaxy; (4) Possibly, one imagines, by the too strenuous use of cystodiathermy.

SUPRAPUBIC CYSTOSTOMY

Catastrophic catheterization predisposes to shock and anuria. The danger of emptying suddenly a full bladder was known to our forefathers. The unavoidable abruptness with which the bladder is emptied by the operation of ordinary suprapubic cystostomy puts catastrophic catheterization into the shade. No doubt exists in my mind that to open the bladder suddenly is extremely dangerous.

On Christmas Eve, 1921, I was asked to perform suprapubic cystostomy upon a man who had been admitted the previous night with acute retention. His retention, due to an enlarged prostate, had been relieved soon after admission by the passage of a bi-coudé catheter. It was also pointed out that the morrow was Christmas Day, with its arduous calls upon the resident staff. Suprapubic cystostomy was duly performed, the bladder being considerably distended at the time, and the urine gushed forth. This was the last urine that the man passed. For four days he had complete anuria which failed to respond to the usual remedies. He died in coma on the fifth day. At the necropsy a benign enlargement of the prostate was found, but the kidneys showed no gross abnormality.

It is improbable that this disaster would have occurred had suprapubic catheterization (*see* p. 370) been substituted for ordinary suprapubic cystostomy, for with the former the outflow of urine can be controlled. *Open suprapubic cystostomy is therefore contra-indicated in acute retention.*

Indications. The indications for open suprapubic cystostomy as an emergency should be limited to the following: —

1. As the preliminary step in the treatment of complete rupture of the urethra.

2. As a means of treating extraperitoneal rupture of the bladder.

3. When acute prostatic retention, which has been relieved by a catheter, is threatening to recur.

4. In certain cases of cystitis where pain and frequency are intolerable.

5. For the removal of foreign bodies which cannot be extracted by an operating cystoscope.

6. For the evacuation of blood-clot. (This should be reserved for those cases in which the cause of the haemorrhage is known, and where persistent washing through a catheter has failed to give relief.)

The Operation. The bladder must be at least moderately full. This may be effected by instructing the patient to abstain from

passing urine for a few hours before the operation. If this has not been possible, a catheter may be passed and the bladder filled with 8 oz. of warm boric lotion. Some surgeons prefer air distension of the bladder. In using the latter method a catheter is passed and the urine evacuated; into the butt end of the catheter the nozzle of a Higginson's syringe is inserted; the bladder is inflated, after the cave of Retzius has been opened in the course of the operation, by a nurse compressing the bulb of the syringe with a hand insinuated under the sterile towel.

The incision, about two or two and a half inches in length, is made in the middle line immediately above the pubis. The rectus
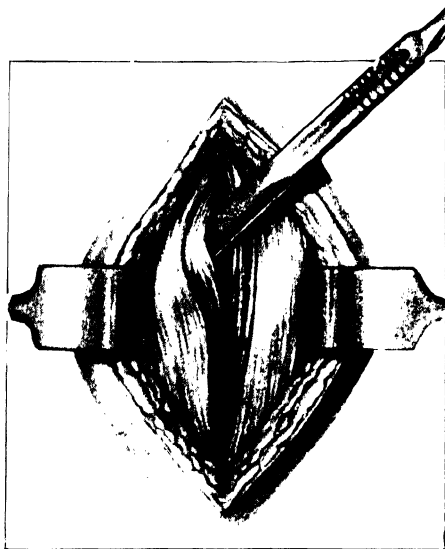
Fig. 330.—Suprapubic cystostomy, with the bla

sheath is opened near the middle line, and the fibres of the rectus muscle are split and separated with the handle of the scalpel (*Fig. 330*). Retractors are inserted, and the index finger of the left hand dives deeply into the cave of Retzius, behind the symphysis pubis. The fat-pad and cellular tissues are hooked upwards (*Fig. 331*). A little dissection with the handle of the scalpel renders this upward reflection possible. This step is the most important in the operation. Using this technique the peritoneum is never seen, and is protected until the bladder is opened. The bladder can be recognized by its muscle fibres and the veins coursing over its surface. Still keeping

the forefinger hooked in the upper angle of the wound, the bladder
is caught in a pair of Lane's tissue forceps; a fairly substantial bite is
necessary, in order to prevent tearing out.   A second tissue forceps
is applied a little to the left of the first and is given to the assistant
to hold; tension is applied, and a scalpel, with its cutting edge

Fig. 331. Suprapubic cystostomy.   The suprapubic fat pad is reflected
upwards by gauze dissection.   The peritoneum is thus protected; in most cases
it is not even seen.   Note the vessels coursing over the bladder musculature, a
spectacle which enables the operator to recognize the bladder immediately.

towards the symphysis, is plunged into the bladder between these
forceps (*Fig. 333*).   On removing the scalpel the finger is inserted
nto the bladder, and the organ explored.

The type of drainage which is to be used will vary according to the
nature of the case.   Broadly speaking, it will be found useful to use a
de Pezzer catheter (*Fig. 332*) for non-infected cases and a wide-bore
drainage tube for infected cases.   If the latter is to be used, the stab

Fig. 332. De Pezzer's catheter.

incision in the bladder will have to be enlarged somewhat for the
drainage tube.   The bladder is now closed about the tube.   The
ends of one of the sutures which close the bladder are left long and
brought through the rectus sheath on each side and then tied.   This
prevents the collapsed bladder sinking into the depths of the wound.

The remainder of the rectus sheath is approximated with interrupted sutures except at the extreme lower end, where a small rubber tube

Fig. 333.—Suprapubic cystotomy. The bladder is picked up at two points by Lane's tissue forceps. Between these a scalpel is passed into the bladder. The blade of the knife is directed towards the pubis and the opening into the bladder enlarged in a downward direction only; alternatively a transverse incision can be employed. Note the gauze swab protecting the peritoneum.

is placed; always drain the cave of Retzius. The operation is completed by closing the skin and anchoring the tubes with suitable skin stitches.

If a de Pezzer catheter is to be used, the technique is a little different. The wound in the bladder should be kept as small as

Fig. 334.—Method of stretching a de Pezzer catheter with a haemostat.

possible. The de Pezzer tube may be introduced on its special holder (*Fig.* 335), or—what I find more convenient—the mushroom end

may be stretched on a long hæmostat (*Fig. 334*). Once the mush-
room end is in the bladder, the bladder wound is approximated about
the catheter so as to make a watertight junction. The abdominal
wound is now closed. A stitch
should always anchor the catheter
to the skin. This little precaution
will prevent the annoying com-
plication of the semi-conscious
patient pulling out his catheter.

After-Treatment. *If a de
Pezzer's catheter has been employed*
there is no better method than
to connect this to a St. Mark's
pattern bladder collector-irrigator
(*Fig. 337*). It will be unneces-
sary to change the catheter at
least for several weeks. The old
catheter is removed by a sudden,
sharp pull, and the new one,
stretched on its special introducer
(*Fig. 335*) is pushed in down
the track, by now well lined with
granulation tissue.

*If open suprapubic drainage
has been performed,* Irving's box
(*Fig. 336*), or one of its modi-
fications, is probably the best
method of collecting the urine.
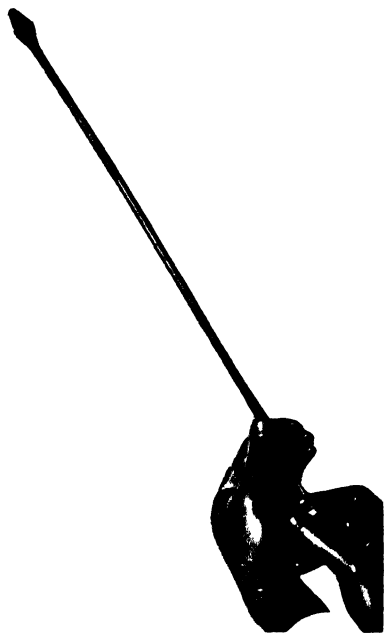
Fig. 335. De Pezzer catheter stretched
on its special introducer ready for insert-
ing into the bladder.
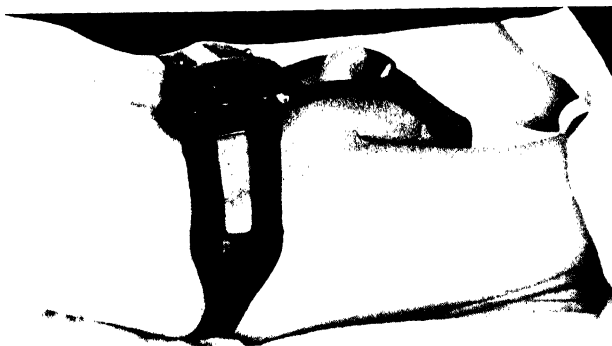
Fig. 336. Irving's box in use after suprapubic cystostomy. A catheter has
been fixed temporarily in the urethra for the purpose of thorough retrograde irriga-
tion of the bladder.

BLADDER WASHES

Bladder washes should be given at 110° F. that is, the wash in the jug should be of this temperature ; by the time it has reached the bladder after traversing the funnel and tube the temperature will be considerably lower.

The following washes will be found of use :—

1. Dilute a saturated solution of boric acid with an equal volume of water.
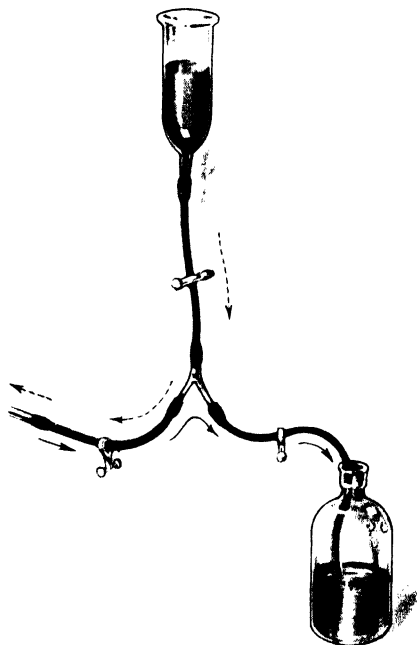
Fig. 327.—St. Mark's apparatus for bladder irrigation. By ⁩ ⁩ ⁩easing the appropriate clips on the tubing the bladder is filled with the ⁩ ⁩ ⁩ In the interval between the washes the urine drains into the bottle.

2. Oxycyanide of mercury (1–2000). Very useful in infected cases.

3. Silver nitrate (1–10,000) may be employed as an alternative to (2) in stubborn cases.

4. Mercurochrome (1 per cent) is an exceedingly good bladder wash. It appears to be efficacious both in the prevention and the treatment of cystitis.

The St. Mark's apparatus (*Fig.* 337) for washing the bladder at regular intervals can be improvised easily. It saves the patient from repeated disturbance and spares the nurse a great deal of labour.

ACUTE RETENTION OF URINE

The relief of acute retention of urine is still too often looked upon as a minor matter, and but little attention is paid to either asepsis or technique.

Catheterization for acute retention, especially that occurring for the first time, should never be performed without cleansing the glans penis, washing out the urethra, and passing with surgically clean hands a sterile instrument smeared with a sterile lubricant. After the operation the patient should be kept in bed for at least twenty-four hours. He should be given urinary antiseptics, and not discharged permanently until the cause of the obstruction has been investigated adequately and arrangements made for its treatment. All but improvident patients will fall in with these arrangements.

Enlargement of the prostate and stricture of the urethra together account for about 90 per cent of cases of acute retention. Both these conditions are supremely remediable, and due thought should be given not only to the momentary relief of the existing attack, but to planning the means of ridding the patient of the obstruction permanently. With this object in view the treatment of urinary obstruction becomes an interesting study not beneath the dignity of the most fastidious.

When undertaking a case of acute retention two fundamental objectives are: (1) To prevent infection; (2) To avoid laceration of the urethra. As both these basic faults are still much in evidence, it follows that some radical change in the teaching concerning these cases is indicated.

Metal catheters should be forbidden. It can be said, without overstating the case, that there is never any occasion to use this notorious maker of false passages. It has caused too much pain and laceration to warrant a place in our armamentarium. A terrified, exhausted, but unrelieved patient bleeding severely from the meatus is a clinical entity in any large hospital. Twice I have come across cases where " the beak of the catheter appeared in the groin ". The small metal catheter is one of the most dangerous weapons in surgery.

The tied-in catheter should be employed seldom unless very special precautions are taken. If a catheter is tied in for several days, considerable infection is inevitable. The bedclothes, the patient's hands, flatus, and the bed-pan must predispose to all the dangers attendant upon an ascending infection. True, a stopper in the end of the catheter to some degree mitigates these untoward possibilities; but an intermittent, crudely fitting stopper must be a feeble barrier to the march of myriads of micro-organisms.

The necessity for repeated catheterization should be circumvented. If repeated catheterization could be carried out with care and due

observance of asepsis, it would do little harm. Often such care is
bestowed lavishly at the first and second operations; eventually
a time arrives when the patient becomes distended at an inconvenient
moment; it is then that an element of risk creeps in.

THE MANAGEMENT OF URGENT ACUTE RETENTION FROM ORGANIC OBSTRUCTION

Acute retention from organic obstruction should be called more
correctly acute on chronic retention, for the retention seldom occurs
unheralded.

Providing the patient's general condition is satisfactory, the
time-honoured ¼ gr. of morphia and a hot bath may be tried; in
a small proportion of cases the retention is relieved naturally in the
bath. If this measure has been tried and has failed, it is improbable
that a soft rubber catheter will pass the obstruction; it is better to
select a gum-elastic instrument.
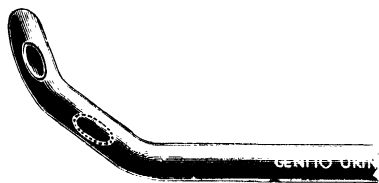
Sterilization of Gum-elastic Instruments.—It should be appreci-
ated that modern gum-elastic catheters are boilable, and with due
care they can stand repeated boiling. The catheter should be
plunged for two minutes into water already boiling. It must be
removed carefully by its wide end and dropped into sterile cold
water or cold weak antiseptic lotion before use.

Technique of Sterile Catheterization.—The glans and the urethra
having been cleansed, the catheter is lifted out of the lotion by its
dilated extremity and a few drops of antiseptic lubricant are allowed
to fall on its tip. No portion of the catheter which enters the patient's
urethra should be touched. The penis is kept stretched vertically
while the instrument is passed, and the watchword for urethral
instrumentation is, as always, *arte non vi.*

The Case is one of Enlargement of the Prostate.—When possible,
choose a large bi-coudé gum-elastic instrument (*Fig.* 338). The difficult
point to pass is where the middle lobe commences, i.e., about half-way
down the prostatic urethra. The double bend of the bi-coudé helps
to surmount this obstacle. At times the left index finger in the
rectum may help to lever the tip of a catheter into the bladder. It

should be noted that pressure must be exerted not far from the anal verge, over the apex of the prostate (*Fig. 339*).

If, in an emergency, a suitable gum-elastic instrument cannot be obtained and a rubber catheter will not pass the obstruction, a large silver catheter must be tried.
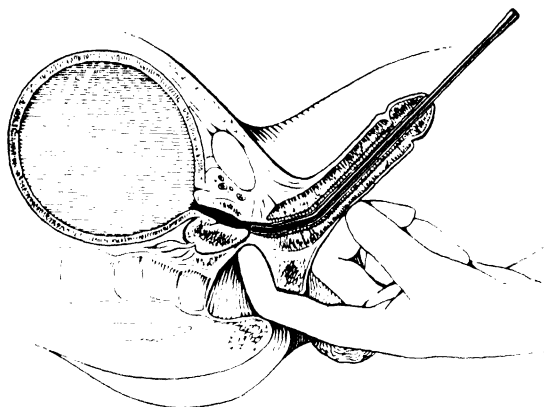
Fig. 339.—A finger in the rectum aiding the passage of the catheter in a difficult case of prostatic obstruction.

The Case is one of Urethral Stricture. Employ the instrument in which you are most experienced. Usually the olivary catheter is used.

Fig. 340. Phillips' catheter. The guide is inserted through the stricture, after which the catheter is screwed on to the guide.

A Phillips catheter (*Fig. 340*) is a very good instrument in cases of stricture, and one with which it is impossible to lacerate the urethra. When such an instrument has not been at hand I have several times used a fine gum-elastic bougie, passed, if necessary, by the faggot method (*Fig. 341*). This answers the purpose admirably, for urine trickles slowly alongside the instrument and lo! our very objective — namely, slow decompression of the bladder — is accomplished.
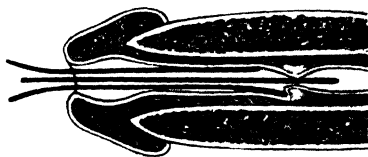
Fig. 341. The faggot method of passing bougies.

DECOMPRESSING THE DISTENDED BLADDER

Once a catheter has entered a distended bladder, the urine must always be let out slowly. Whilst decompression is in progress the catheter is temporary fixed in the urethra, most conveniently by the simple and useful piece of apparatus made by the Genito-urinary Manufacturing Co. (*Fig.* 342). Another method which requires a safety-pin, tape, and narrow adhesive plaster, is illustrated in *Fig.* 343.
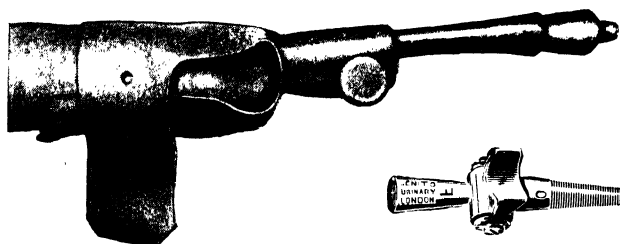
Fig. 342. Method of temporarily retaining a catheter in position during decompression of the bladder. The catheter retainer is made of sheet rubber, fitted with collar-studs to fasten it in position. The stopper at the end of the catheter is removed every hour, and 4 oz. of urine is allowed to escape. *Inset* Catheter tap.
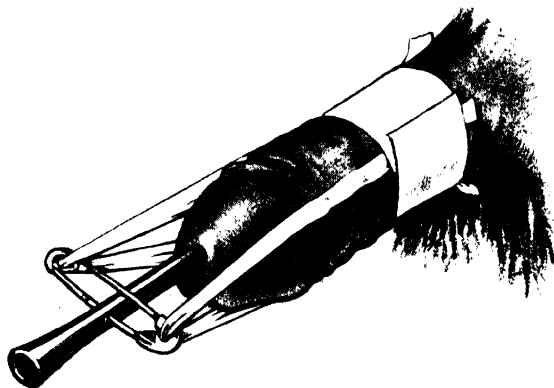
Fig. 343.—Method of tying in a catheter. A sterile safety-pin, tape and adhesive plaster are employed as shown.

Methods of Controlling the Escape of Urine.

For generations catastrophic catheterization has been eschewed by the initiated. A bung in the catheter's mouth, useful as it is, is still the only means of controlling the outflow known to the majority of the profession. Kidd's ∪-tube (*Fig.* 344), which is simplicity

itself, allows decompression of the bladder to be carried out with scientific accuracy. The air vent obviates syphonage, and the U-tube is slung at such a height that the urine just trickles over when the patient coughs. In general, the instructions are that it should be lowered 2 in. per diem.

A home-made apparatus is equally effective and it can be rigged up in the patient's home with materials which are obtained easily. *Fig.* 345 makes a detailed description of the apparatus unnecessary. We will assume that a gum-elastic catheter has been introduced through the urethra and has been tied in. Into the mouth of the catheter is placed an ordinary glass nozzle, the tip of which has been dipped in collodion; the junction is further secured by whipping it round with a strip

Fig. 344.—
Kidd's
U-tube.
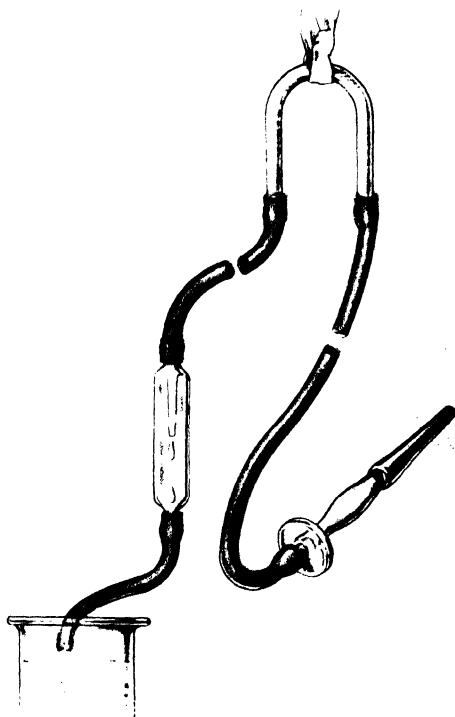
Fig. 345.—'Home-made' apparatus for decompression. The nozzle of a Higginson's syringe, a piece of glass tubing bent in a Bunsen flame, and an interrupter from a saline apparatus are the requisites.

of narrow gauze moistened with collodion. In order to support the penis connected to the apparatus, a piece of broad adhesive is applied to the thighs, so as to form a sling between them. Upon this sling rests the nozzle. To minimize the great drawback to the tied-in catheter—urethritis—the penis is wrapped in gauze soaked in flavine. Some homely object can usually be found upon which to hang the U-tube at a correct hydrostatic level. For instance, I have borrowed the hat-stand from the hall. Decompression of the bladder by the U-tube should, I think, be the method of choice. Its simple principles can be applied even in remote districts. Asepsis is far more assured, and the rate of emptying is controlled, not by rough calculation, but with the precision of gauge-controlled hydrostatic pressures.

RECOMPRESSING THE TOO-RAPIDLY DECOMPRESSED BLADDER

The correct treatment after too rapid decompression is to refill and recompress the bladder with normal saline or lotion, and to start decompression anew. As soon as this has been attended to, energetic urgent measures to combat oliguria and uræmia must be pursued. Briefly, they are venesection and venoclysis. For fuller details refer to p. 322.

THE URGENT PROBLEM OF THE FULL BLADDER
WHEN CATHETERIZATION HAS FAILED

If after a reasonable attempt with catheters the bladder has not been entered, according to circumstances one of two courses must be adopted :

1. Suprapubic catheterization.
2. Suprapubic puncture.

1. **Suprapubic Catheterization.**—Again it is emphasized that ordinary suprapubic cystotomy, which allows the urine to gush forth, must be avoided. The aim is to introduce a mushroom-ended catheter into the bladder without spilling more than a few drachms of urine. There are many ways of achieving this end, but after trying them all I will describe the one which I think in the long run will be found the safest and most satisfactory.

The essential armamentarium is a No. 28 reinforced Malecot catheter (*Fig.* 347). The type of bladder perforator shown in *Fig.* 348 is inexpensive, and a most useful instrument to possess.

The front of the distended bladder is exposed through a short suprapubic incision, and the bladder wall, with tortuous veins coursing over it, is seen clearly (*Fig.* 346). Local anæsthesia can be used and I employ it as a general rule. During the infiltration there is a danger of pricking an over-distended and infected organ, but with care this can be avoided. If a skilled anæsthetist is available a little gas and oxygen can be employed instead. Evipan can be used, but it is said to be dangerous when the renal function is impaired. The bladder

perforator is armed with a Malecot catheter (*Fig.* 347), which is
stretched over the perforator as shown in *Fig.* 348. The end of the
Malecot having been dipped in paraffin, all is in readiness for its

Fig. 346. Suprapubic cystostomy. The suprapubic fat pad is reflected
upwards by gauze dissection. The peritoneum is thus protected; in most cases
it is not even seen. Note the vessels coursing over the bladder musculature, a
spectacle which enables the operator to recognize the bladder immediately.

insertion into the bladder. This is done in the twinkling of an eye
with a short, sharp stab (*Fig.* 349). The introducer is disengaged

Fig. 347. Malecot catheter. The special rein-
forced model is essential for successful use with the
bladder perforator.

while the end of the catheter
is pinched prior to clipping
it with a hæmostat. A few
drops only of urine escape
around the puncture. Drain-
age of the cave of Retzius is
provided, using a strip of
corrugated rubber. The ab-
dominal wall is approximated with substantial silkworm gut sutures,
not forgetting to anchor the catheter with one of these.

Fig. 348.—A, Bladder perforator; B, Shows
a No. 28 reinforced Malecot catheter stretched
over the bladder perforator.

If the special perforator is not obtainable the Malecot catheter
can be stretched over a narrow-bladed scalpel (*Fig.* 350). This is

not so satisfactory, and requires some deftness, but in cases of necessity it serves its purpose.   If, when this method has been used, there is more leakage about the catheter than desirable, a single catgut suture through the upper part of the bladder puncture will help to make a water-tight junction.

It will thus be seen that there is only one essential instrument needed for suprapubic catheterization, and that is a No. 28 Malecot catheter.

Fig. 349.—Introducing a suprapubic catheter into the es   d over-full bladder by means of the bladder perforat

As soon as the patient is back in bed the catheter is connected with a hydrostatic decompression apparatus, either Kidd's U-tube or the glass U-tube described on p. 369.   The U-tube is raised to a height of about 3 feet above the patient and the hæmostat on the catheter is released.   The U-tube is lowered gradually until the point is reached where urine just commences to trickle over when the patient coughs.   At this height it is fixed to a stand (*Fig.* 351) and each day it is lowered 2 in. until the bladder is decompressed completely.
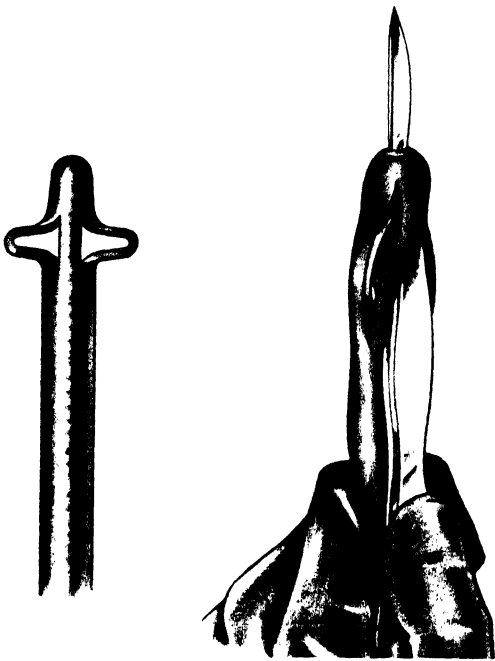
e] can be used as a bladder perforato
f a special instrument.
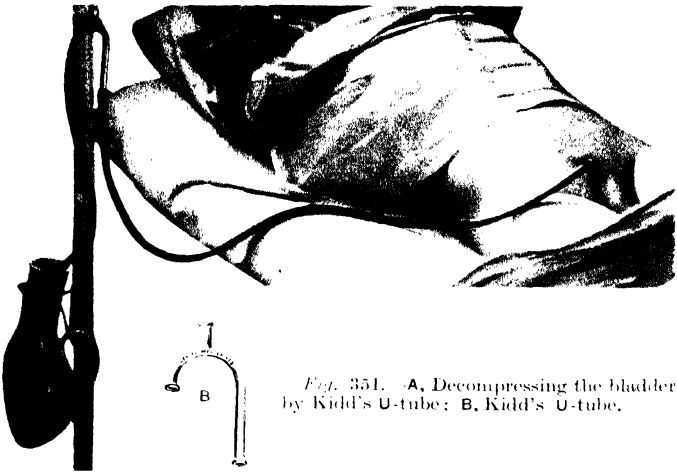
Fig. 351.   A, Decompressing the bladder
by Kidd's U-tube; B, Kidd's U-tube.

2. Suprapubic Puncture with a Hollow Needle.—Suprapubic

puncture (*Fig.* 352) is a useful method of relieving acute retention
when catheterization has failed and the circumstances are extenu-
ating. If the circumstances remain extenuating and a catheter still
cannot be passed, as in the case cited below, the puncture may
be repeated. Repeated puncture is only permissible in exceptional
circumstances, for it is dangerous to allow the bladder to refill
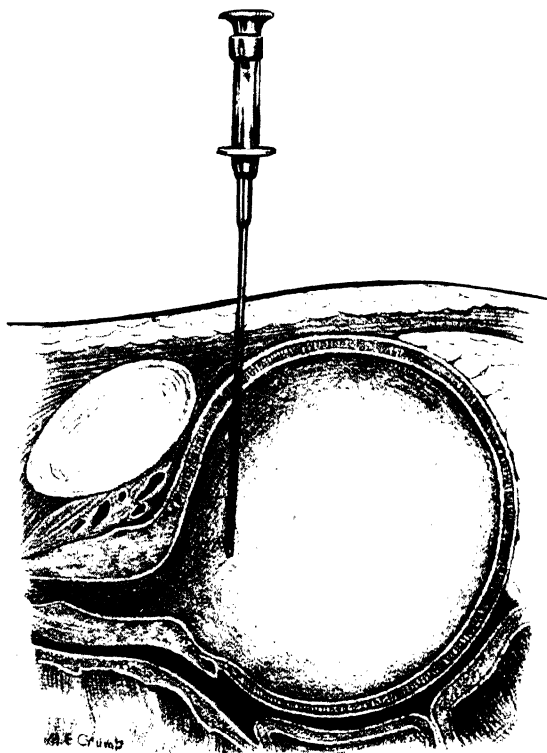
Fig. 352.—Suprapubic puncture with a lumbar puncture needle. Th
is inserted very near the top of the symphysis pubis.

after it has been punctured; leakage is liable to occur into the
cave of Retzius (*Fig.* 353). By one of those curious coincidences
which pursue surgical practice, I operated during the same night upon
two cases of extravasation of urine with spreading cellulitis of the
abdominal wall due to this cause. One case occurred within the
hospital, whilst the other was admitted from an outlying country
district. It is obvious that the smaller the puncture hole the less

likely is this leakage to occur; therefore the finest lumbar puncture needle obtainable is recommended for the operation.

The following experience shows the inestimable value of suprapubic puncture :—

Whilst employed as surgeon in a small gunboat during the war, I was summoned in the middle of the night to an officer's cabin. The case was one of acute retention from stricture, and the bladder extended half way to the umbilicus. Morphia, gr. ¼, and hot flannels to the hypogastrium produced no relief. There was a very small selection of instruments aboard, and none could be made to pass the stricture. The pubes was therefore shaved and suprapubic puncture performed with a lumbar puncture needle. The next morning catheterization was again attempted, but the stricture

Fig. 353. Suprapubic puncture has been performed and the bladder has been allowed to refill to a point of tension. Leakage is taking place through the vesical puncture into the cave of Retzius.

was impassable. The retention was relieved three times by suprapubic puncture before the patient could be got ashore to hospital. No extravasation took place. The patient recovered after internal urethrotomy.

RETENTION WITH OVERFLOW

Retention with overflow should be looked upon with great circumspection. However carefully treated by the usual methods, the mortality amongst these cases is appalling. All are agreed that the bladder should be decompressed exceptionally slowly. Nevertheless the high mortality associated with retention with overflow makes it only too apparent that even the careful hydrostatic decompression described already is too rapid for these patients. My suggestion for the treatment of retention with overflow is as follows : (1) When the patient is admitted the level of the bladder is marked clearly upon the abdominal wall. (2) The administration of continuous intravenous saline and glucose is commenced. (3) About six hours later the urethra is catheterized (a catheter can usually be passed) and the usual hydrostatic decompression apparatus is rigged up. Every six hours the amount of urine which has been passed is measured, *and three-quarters of its volume of normal saline is run into the bladder.* Later a half and later still a quarter of the volume is returned. The check is the mark upon the abdominal wall, and the aim is to lower that level by a finger-breadth each day.

By employing such measures we may hope to save more of these frail patients.

CLOT RETENTION

Blood-clot in the bladder sometimes causes acute retention. I have seen several cases follow nephrolithotomy. I had also an interesting example in a middle-aged woman due to hæmorrhage from a Hunner's ulcer of the bladder. Curiously, malignant disease and papilloma seldom give rise to clot retention, although hæmaturia is often severe.

The passage of a catheter relieves the retention, and repeated washings through a catheter of wide bore sometimes evacuate the clot. *Blood-clot in the bladder is certain to become infected.*

If the source of the bleeding is known and it is estimated that there is a considerable amount of clot in the bladder, it is best to evacuate the clots by suprapubic cystostomy. This measure avoids decomposition of the blood and the attendant dangers of purulent cystitis.

RETENTION FROM PARALYSIS OF THE BLADDER
FOLLOWING LESIONS OF THE SPINAL CORD

Catheterization should be avoided absolutely, for if it is used a serious infection always supervenes eventually. Automatic emptying of the bladder can sometimes be established, and repeated low spinal anæsthesia helps in aiding automaticity. The best way of treating these difficult cases is to perform suprapubic cystotomy, leaving in a de Pezzer's catheter. This should be connected to a St. Mark's apparatus (*see Fig. 337*). If later automaticity can be established, the suprapubic cystostomy opening can be closed.

POST-OPERATIVE RETENTION
(*See* p. 314).

IMPACTED URETHRAL CALCULUS

Retention due to the impaction of a calculus in the urethra is rather uncommon. Usually the retention is only partial, but the pain of a stone in this situation is intense. Systematic palpation of the course of the urethra usually reveals the site of the impaction, which is not infrequently behind a stricture or a narrow external urinary meatus.

B. D., aged 21, was passing water when the stream stopped suddenly. He was seized with agonizing pain referred to the end of the penis. Very soon afterwards he had an intense desire to micturate, but found that he was unable to do so. When admitted to hospital six hours later the bladder extended half way to the umbilicus. On palpating the course of the urethra a hard object could be felt one and a half inches from the meatus. Borocaine was injected into the urethra with a view to attempting removal by intra-urethral manipulation, but the patient could not bear the penis to be touched. A general anæsthetic was therefore given. As soon as the patient was fully anæsthetized the stone was spontaneously extruded at the head of a jet of urine which spurted out under considerable pressure.

Bivona's method of releasing a calculus may be tried.   When the obturation is partial this simple device is sometimes effective.   Local anaesthetic is injected, the patient passes urine, and suddenly interrupts

Fig. 354.   Large stone imp.

the stream by compressing the end of the penis.   The urethra is dilated, and the stone may be swept onwards.

A stone impacted in the fossa navicularis can be dislodged at once by performing meatotomy (p. 404).

Sometimes a stone wedged in the penile urethra may be removed with a scoop, aided by the fingers of the left hand on the outside.   Preliminary urethroscopy is advisable.

A stone impacted behind a tight stricture will require external urethrotomy.   Acute retention may be relieved by a suprapubic catheter and the stone extracted at a later date, as was done in the following case :

G. H., aged 29, was admitted with acute retention.   Catheterization had been attempted and he was bleeding from the meatus.   Per

Fig. 355.   Stone which was impacted in the prostatic urethra.   It had to be broken before it could be removed.   The fragments have been cemented together.

rectum a stony mass could be felt in the region of the prostate.   The retention was relieved by decompressing the bladder with a catheter introduced suprapubically.   Later an X-ray (*Fig.* 354) showed a large calculus in the prostatic urethra.   Fourteen days after, the stone was removed via the bladder after incising the internal urinary meatus.   It was found that a No. 4 French bougie could be passed through a stricture of the bulb.   The

suprapubic wound healed and the patient was advised to attend regularly for the dilatation of the stricture : this he failed to do. One year later he was admitted again with acute retention and was once more relieved by a suprapubic catheter. The urine was foul, and on the fifth day open suprapubic cystotomy was carried out and a soft stone removed from the bladder (*Fig.* 355). After weeks of bladder washes the cystitis abated and internal urethrotomy was performed. This time he attended regularly for dilatation of the stricture, and the end-result was perfectly satisfactory.

When dealing with stones in the posterior urethra, an attempt should be made to push the stone backwards into the bladder, and there to deal with it by crushing or by removing it suprapubically.

PERI-URETHRAL ABSCESS WITH EXTRAVASATION

" When the urethra has given way behind a stricture and urine has become diffused into the cellular texture, very prompt and vigorous measures are necessary. Delay is fatal." —(*Sir Benjamin Brodie.*)

The two great indications in treatment are to mitigate the blood infection and combat the uræmia. The first is carried out by making adequate incisions to relieve tension and admit of the free escape of urine and inflammatory products. If, is commonly the the patient exhibits uræmic symptoms, the stricture is probably a tight one, and the uræmia is due to retention reacting upon kidneys already seriously damaged by backward pressure, which has extended over a long period. It is therefore of the utmost importance to drain the bladder. It is not enough to make incisions into the inflamed area (*Fig.* 356), or even to divide the stricture in addition. The bladder must be drained. To drain the bladder suprapubically is most dangerous. Of necessity, the cystotomy incision traverses the infected superficial plane and incurs the danger of leading to a deep pelvic cellulitis—a very grave complication. Further, if the bladder is much distended and the patient uræmic, immediate suprapubic cystotomy will depress the renal function still further.
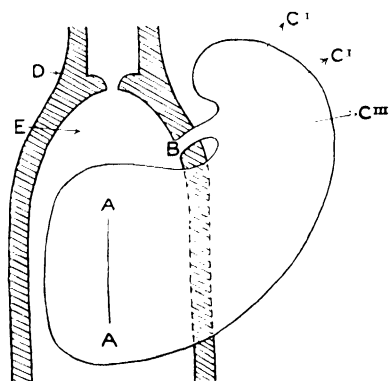
Fig. 356. An explanation of that a simple incision into a peri- abscess does not usually open the and drain the bladder. A–A is an into the peri-urethral abscess which municates with the urethra through a lateral orifice (B) behind the stricture. C¹, C¹¹, C¹¹¹, is that part of the abscess w ll which has given way, and through wh urine and pus are extravasating. D, Stri ure ; E, Dilated urethra.

The following line of treatment has given excellent results. The urethra is washed out, and borocaine instilled. An attempt is made

to pass a bougie into the bladder. Great gentleness is exercised, for the urethra, being inflamed, may easily be perforated. However, it is usually possible to pass a No. 3 or a No. 4 French. In the absence of an instrument by which the bougie can be passed under direct vision, the 'faggot method' (*Fig.* 357) of introduction is of distinct value. The introduction of a guide simplifies the subsequent stages of the operation. If the bougie has been passed, it should be fixed in position. A good method of fixing the bougie is to clip a hæmostat on to its extremity to prevent it passing in, and to tie a turn of bandage moderately tightly (behind the corona around the penis) to prevent it slipping out. The patient is now anæsthetized. Spinal anæsthesia is indicated, for the uræmic condition of the patient renders a general anæsthetic dangerous. The use of spinal anæsthesia in these cases is a great factor in reducing mortality.
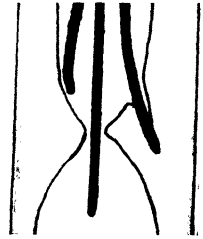
Fig. 357. Faggot method of passing bougies.

A Bougie has Failed to Pass through the Stricture.—*Cock's operation* should be performed (*see* p. 382).

A Bougie has been Passed (which will be found possible in the majority of cases). — The patient is placed in the lithotomy position. A sandbag placed under the sacrum exaggerates effectively this position. Two pairs of Lane's tissue forceps are clipped upon the most dependent part of the infiltrated scrotum. The passing of a long loop of bandage through the handles will enable the anæsthetist at the patient's head to utilize these

Fig. 358.- Peri-urethral abscess with extravasation. The perineal stage of the operation. Note the method of maintaining the bougie in position. A hæmostat prevents it going in too far, whilst a turn of bandage tied behind the glans prevents its coming out. Lane's tissue forceps are acting as scrotal retractors.

forceps as scrotal retractors, and thereby the perineum will be clearly exposed to view. Towels having been arranged, an incision is made from the base of the scrotum to within half an inch of the anal verge, keeping strictly to the middle line. The tissues in this region being extensively infiltrated, it is usual to find that one has to proceed to a depth of three-quarters of an inch or more before the abscess is reached. Urine and pus then escape, usually under considerable pressure. A finger is now passed into the wound, and the bougie within the urethra (*Fig.* 358) sought for by palpation. Retractors are placed in either side of the wound, and the urethra is inspected. The floor of the urethra is incised and the edges are retracted. The left index finger is passed into the dilated urethra, with the pulp against the bougie. The finger is then guided into the bladder. A large coudé catheter is now passed through the incision along the index finger into the bladder, and secured to one side of the wound with a stitch (*Fig.* 359). The usual precaution of gradually emptying the bladder should be observed.

Fig. 359. –Method of perforating a gum-elastic catheter prior to passing a silk thread. A towel clip is used to pierce the end of the catheter. To endeavour to pass a needle through a gum-elastic catheter without this preliminary step entails a great deal of trouble.

Drainage of the Cellular Tissues (*Figs.* 360, 361). The left forefinger is passed through the perineal wound, upwards and outwards, clearing the crus penis, and made to protrude subcutaneously above and to the outer side of the symphysis pubis ; the skin is then incised over the finger, and long blunt-nosed forceps retrace the path and emerge in the perineal wound. The jaws are opened and grasp a ¼-in. drainage tube, previously perforated, which is then pulled up and fixed by a stitch. This procedure is repeated on the opposite side.

Incisions into the Infiltrated Tissues. In contrast to the older methods, fewer but larger incisions are recommended. There is a tendency, on account of the infiltration, for the incisions to be too superficial ; they must be of sufficient depth to penetrate the limiting fasciæ.

Injections of Hydrogen Peroxide. It has been shown that anaerobic organisms are largely responsible for the spreading cellulitis in these cases. As oxygen is inimical to such organisms, hydrogen peroxide is injected here and there into the subcutaneous tissues with an aspirating syringe.

Dressings. –Moist dressings of eusol are applied over the abdominal wall, perineum, and scrotum ; these are covered over by packing towels, and the whole is secured by a T-shaped bandage.

After-treatment.—During the first twenty-four hours the patient is encouraged to drink as much fluid as possible ; rigors are usual during this period, and are most successfully combated by hot gin and quinine.
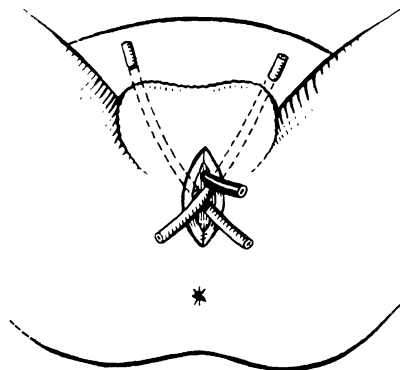
Fig. 360.   Method of drainage of the cellular tissues in extrav urine.   (*After Hartmann.*)

The catheter is removed at the end of forty-eight hours.   Every four hours all the wounds are irrigated with eusol through a Higginson's syringe, after hydrogen peroxide has been instilled for a few minutes.

Fig. 361.— Patient convalescent from peri-urethral abscess with extravasation.   A, A, Site of subcutaneous tubes referred to in text ;   B, Long incision into the infiltrated tissues.

Urinary antiseptics are prescribed, and in necessary cases continuous intravenous saline is given.   On the fourth day, shortening of the

tubes should be commenced.   As soon as the general condition permits, sitz baths are instituted.

Residual abscess is frequently seen in the flank just above the anterior superior iliac spine.   Under gas anæsthesia the abscess should be opened freely.

When the infection has subsided, which is usually in about three to four weeks, the treatment of the perineal fistula should receive attention. If the stricture has not been divided, an internal urethrotomy with insertion of a catheter is an effective method of dealing with the condition and hastening the closure of the wound.   Occasionally it may be possible simply to dilate the stricture with bougies.

The patient should not be discharged until

Fig. 362.—Cock's operation.   The finger in the rectum rests on the apex of the prostate and acts a guide.

the fistula is closed, and the stricture must then be dilated regularly.

Cock's Operation.—Cock's operation is an external urethrotomy which opens the urethra behind the stricture and without a guide. It   indicated   those cases of peri-urethral abscess and extra-
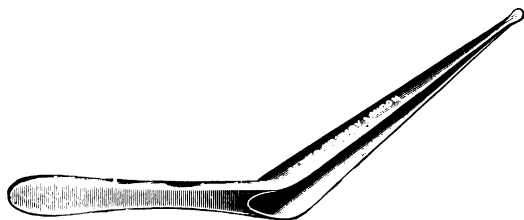
Fig. 363.   Teale's probe-pointed gorget.

vasation in which a bougie cannot be passed. These cases are very few and far between.

Technique. —Lithotomy position.   It is of the utmost importance that the body and the pelvis should be straight so that the median line may be accurately preserved.   The left finger is introduced into the rectum and the tip of the finger is lodged at the apex of the prostate (*Fig.* 362).   The knife (Cock used a double-edged knife) is plunged steadily but boldly into the middle line of the perineum and carried on towards the tip of the left forefinger.   The point of the knife enters the dilated urethra just in front of the apex of the

prostate. When it is certain that the knife has penetrated the urethra, the instrument is withdrawn, but the left forefinger remains in position. Teale's probe-pointed gorget (*Fig*. 363) is carried through the wound, and, guided by the left forefinger, enters the urethra and is passed into the bladder. A large coudé catheter is slid along the director, which is then removed, and the catheter, having been cut short, is secured to one side of the wound with a stitch.

HÆMORRHAGE AFTER PROSTATECTOMY

Pilcher's bag (*Fig*. 364) and its modifications have reduced the number of cases of this serious complication. If a bag has been inserted at the close of the operation and bleeding subsequently occurs, the bag should be inflated with air by means of a Higginson's syringe. Two, or at the most three, syringefuls of air or water should be forced into the bag, but no more. Before the syringe is detached a tight ligature is applied at the end of the smaller rubber tube to keep the bag distended. A length of tape, long enough to pass over the bed-rail at the foot of the bed, is then attached to the larger tube issuing from the meatus. A 3-oz. weight is attached to the end of the tape, and a bed-cradle prevents the tape becoming displaced by the bedclothes. By these means extension is applied, ensuring the retention of the bag within the cavity, and preventing

Fig. 364. Pilcher's bag for controllin hæmorrhage from the prostatic cave aft the prostate has been removed.

its working upwards into the bladder proper, where it would be useless.

Hot bladder washes are useful, but it should be very carefully noted that the temperature of the wash-out be not more than 110° F. when placed in the jug from which it is poured into the funnel and tube. Twice in my practice has the wash-out been given too hot, and the abdominal wall, and doubtless the bladder wall as well, has been severely burnt. One of these cases proved fatal. The other patient, a wiry man of 83, recovered after being in hospital six months — a large part of the skin of the abdominal wall having sloughed. Make a special point of impressing upon the nurse that the temperature of the wash-out must on no account be more than 110° F. Two ounces of adrenalin may be added to the final wash-out with advantage.

Severe bleeding is occurring: the wash-out has failed: no bag has been placed in the cavity. Cut the stitch and remove the suprapubic tube. See that it is a short tube. Freyer made the point that a long

tube projecting into the prostatic cavity was a potent cause of hæmor-
rhage by preventing contraction of the prostatic capsule. Whilst a
gas apparatus and dressings are being obtained, give another bladder
wash. Under gas anæsthesia, pack the cavity with strip gauze soaked
in *hydrogen peroxide*, or insert a Pilcher's bag.

In all cases block the foot of the bed and institute the general
treatment of hæmorrhage and shock, according to the needs of the
patient. The fact that the patient has been bleeding recently should
not deter you from giving intravenous gum saline, or a blood trans-
fusion if necessary.

Whenever serious bleeding has occurred after prostatectomy, it
is a wise precaution to give a blood transfusion. In cases where the
hæmorrhage commences again it usually indicates that a piece of pros-
tate has been left behind. When, after repeated transfusions, the
bleeding still recurs, it is often advisable to explore the prostatic
cavity with the finger.

Hæmorrhage after transurethral prostatectomy. When the usual
after-treatment of this type of operation does not quickly result in
stopping the hæmorrhage, suprapubic cystostomy should be carried
out. This will help to prevent an ascending pyelonephritis, which
is so apt to occur if infection supervenes.

PROSTATIC ABSCESS

In early cases, or where the condition is only suspected, hot
baths, fomentations, urinary antiseptics, and large doses of tincture
of hyoscyamus are indicated. Retention should be dealt with by
catheterization.
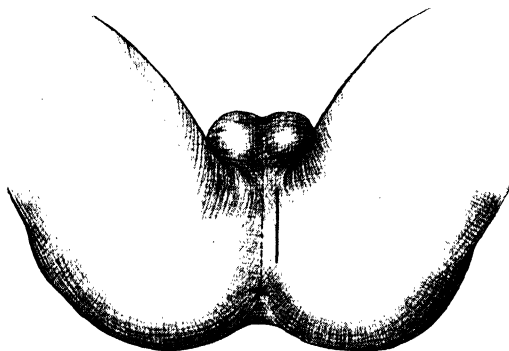
Fig. 365.—Incision for opening a prostatic abscess.

Frequently a prostatic abscess bursts spontaneously into the
urethra. The patient says that he " felt something give way in the
perineum " ; there is immediate relief of pain, and a profuse discharge

of blood and pus from the urethra. In other cases the passage of a catheter is the determining factor in rupturing the abscess. Sometimes the abscess can be felt pointing into the rectum ; it should not be allowed to burst through, for a urethro-rectal fistula is a most unpleasant complication.

McCarthy collected 104 cases of prostatic abscess. *The abscess opened spontaneously in 74, but in 27 per cent of these the result was unsatisfactory.* McCarthy is of the opinion that a large abscess of the prostate should be drained surgically *regardless of whether or not it has opened spontaneously.*

Of several methods of draining the abscess, the following will be found to be quite satisfactory :—

With the patient in the exaggerated lithotomy position, start one inch in front of the anus and half an inch to the outer side of the median raphé, and make an incision one and a half inches in length (*Fig.* 365). The finger bores its way through the roof of the extreme anterior part of the ischiorectal fossa. The swollen prostate can be felt, and is opened thoroughly with sinus forceps. Loculi are broken down with the finger, and a drainage tube is stitched into position.

ACUTE SEMINAL VESICULITIS

The inflammation is more often subacute than acute. Blood-stained emissions and painful erections are often leading symptoms. There is intense pain on defæcation and a heavy pain in the perineum. The condition may, or may not, be associated with acute prostatitis. Upon rectal examination a tender sausage-like swelling is felt on one or both sides.

In the acute stages local treatment of the urethral inflammation should be suspended. Potassium citrate combined with tincture of hyoscyamus is prescribed. After an enema has been given, suppositories of morphia and ichthyol are often soothing. As the acute infection subsides more active treatment can be invoked. The bladder is filled with urochrome solution, and a large sound is passed. At the next sitting the bladder is filled and the vesicles are massaged in such a way that

Fig. 366. The vas deferens isolated and pressed against the skin by a towel clip.

they will be emptied. If the symptoms do not subside in a few days or metastatic joint complications arise, the advisability of a temporary vasotomy should receive consideration. This can be performed under simple local anæsthesia. The vas is isolated (*Fig.* 366), and about one inch of its length having been exposed, its lumen is

opened. By a mattress suture of silkworm gut passed through the skin beneath it the vas can be fixed temporarily in the wound. This allows irrigation of the vesicle with mercurochrome solution and aids materially in clearing up the infection.

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CHAPTER XXV

THE URETHRA AND PENIS

RUPTURE OF THE URETHRA

" RUPTURE of the urethra is one of the most serious accidents, and unless your skill can prevent the development of a stricture, you are presiding at the opening of a life-long tragedy." (*Rutherford Morison*.)

" Every rupture of the urethra, even the slightest, is a potential stricture." (*Boeckel*.)

RUPTURE OF THE BULBOUS URETHRA

The triad of signs of a ruptured bulbous urethra are : (1) Urethral hæmorrhage ; (2) A perineal hæmatoma ; and (3) Retention of urine. To these may be added a fourth, pain.

Urethral hæmorrhage (*Fig.* 367) is certainly good evidence that the mucosa is involved, but its profusion is no guide to the severity of the rupture. I saw a patient who, three days previously, had stepped on to the lid of a pavement coal-hole which was not securely in place, with the result that one leg went down into the cellar whilst the perineum bore the brunt of the fall. For three days severe urethral hæmorrhage had continued, and the patient was profoundly anæmic, yet an exploring catheter slipped readily into the bladder.

Perineal hæmatoma (*Fig.* 368) is always in evidence, but its size is no guide to the extent of the mucosal tear. It is quite clear that the bulb of the corpus spongiosum may be severely damaged and its ensheathing envelope broken whilst the mucous membrane remains untouched.

Retention of urine is due to a reflex spasm of the compressor urethræ. Proof of this is afforded by the fact that the bladder is sometimes emptied as soon as the patient is anæsthetized fully. This spasm of the compressor prevents extravasation for many hours (*see Fig.* 374).

If the urethra has been ruptured, it is of paramount importance to know whether the lesion is complete or incomplete. By ordinary physical examination it is impossible to obtain this vital information. There is as yet no method by which the extent of the lesion can be inspected conveniently ; aero-urethroscopy in the presence of hæmorrhage is contra-indicated absolutely because of the danger of air embolism. The usual method of differentiating between a complete and an incomplete lesion is by sounding, and for this purpose there

is no better instrument than the coudé catheter, the nose of which
can be made to follow the roof of the urethra. Instrumentation
should only be carried out after the anterior urethra has been washed
out with a mild antiseptic solution. The practice of casualty officers
and others of attempting to pass a catheter with only ordinary
precautions, and the mild infection of the lacerated tissues which
ensues thereby, probably accounts for a large number of traumatic

Fig. 367.— Complete rupture of the bulb of the urethra. Blood is
from the meatus. The patient had fallen astride a few hours before the photo-
graph was taken.

strictures. Sounding should be carried out in the operating theatre,
where asepsis can be assured and operative measures can be undertaken
immediately in necessary cases.

If urgent relief of retention of urine is needed before these facili-
ties are at hand, such as may be the case in remote districts or at
sea, catheterization is still contra-indicated. The bladder should be
emptied by suprapubic aspiration. In cases of ruptured urethra or
suspected rupture, promiscuous catheterization must be abolished.
The catheter *can* be withheld, even in the direst emergency under the
most extenuating circumstances. A case of what proved eventually

to be complete rupture of the urethra occurred on board ship four
days out from Havre. Catheterization was not attempted, retention
being relieved by repeated suprapubic punctures until the ship reached
port, when the patient was transferred to hospital. Extravasation
did not occur. (Marion.)

Incomplete Rupture. Incomplete rupture of the urethra is too
often regarded as a trivial accident, especially by the patient, who
can only be persuaded with difficulty to attend for regular inspection
after he has left hospital. For many years French surgeons, who
have devoted much thought to this subject, have insisted that the
tied-in catheter and the concomitant infection is the most potent
cause of stricture formation.

Fig. 368. Rupture of the bulb of the corpus spongiosum with extravasation
of the blood into the scrotum. In spite of the magnitude of the haematoma, the
urethral mucosa was hardly damaged.

Reginald Harrison, as long ago as 1880, advocated perineal
section as the safest plan of diminishing stricture formation in these
cases. It would be sound teaching to insist that all cases of incom-
plete rupture in which bleeding from the meatus has occurred require
perineal drainage. A catheter brought out in the perineum behind
the point of the rupture, and retained for forty-eight hours, is not
open to the foregoing objection, and can only do good by keeping
the urine away from the damaged mucous membrane.

Complete Rupture without Extravasation. The difficulty which
is sometimes encountered in locating the posterior end of the divided
urethra within the bruised and blood-stained tissues is a byword.

Suprapubic cystotomy with retrograde catheterization circumvents this difficulty; it renders the perineal stage of the operation a swift and certain procedure; in addition, by subsequently preventing the passage of urine over the lacerated tissues, it actually aids in the healing of the damaged mucous membrane. Therefore the first stage in the operation is suprapubic cystotomy. The bladder having been opened, a Lister's sound is introduced down the internal urinary meatus. A

Fig. 369. A bougie has been passed into the internal urinary meatus. The handle is held by an assistant, whilst a plentiful supply of gauze wrapped around the shank protects the suprapubic wound during the perineal stage of the operation.

Fig. 370. Suturing the roof of a completely ruptured bulbous urethra. Note the tip of a bougie in each end of the exposed urethra.

liberal supply of gauze is wrapped round the sound, and this forms an excellent protection to the wound during subsequent manœuvres (*Fig.* 369). A towel is then placed over the gauze and the bougie, leaving the handle free for an assistant to hold. Next, the patient is placed in the lithotomy position, and, a second bougie having been passed from the external meatus, the perineum is opened by a midline incision. Both ends of the urethra are at once accessible. The

external bougie is removed, and the assistant is instructed to withdraw the internal bougie until the point is conveniently out of the field of operation. The roof is sutured by interrupted catgut stitches (*Fig.* 370), and, in order to avoid these cutting out, a firm grip of the corpus spongiosum as well as the mucous membrane should be taken. After the suturing has been completed—two or three sutures suffice—the perineal wound is packed lightly with strip gauze. Dressings having been applied, the patient is taken down from the lithotomy position. Attention is now directed to the suprapubic incision. The bladder is closed about a de Pezzer's catheter, the expanded end of which should be made to lie near the internal urinary meatus.

Occasionally owing to wide separation of the ends of the urethra, it will be found impossible to bring the divided ends of the stricture into apposition by the method detailed. In one such case I used a mattress suture, and after this had been introduced, but before it was tied in, the patient was moved farther up the table in order to lessen tension caused by the lithotomy position. By these means the ends of the urethra could be almost approximated.

Ten months later the patient showed no signs of stricture on urethroscopic examination, and a 14-16 silver bougie slipped readily into the bladder.

Such an excellent result is due more to good luck than to good management. When the ends of the divided urethra are difficult to approximate, it would be better surgery to mobilize the anterior end of the corpus spongiosum (*Fig.* 371) before attempting suture.

After-treatment. The foot of the bed should be raised on blocks, so as to aid the emptying of the bladder by the suprapubic route. A suction apparatus attached to the de Pezzer's catheter is a great advantage. The proximity of the perineal wound to the anus makes infection almost a certainty, and special precautions are needed to ensure healthy granulation, which means so much in the prevention of stricture formation. To this end the bowels should be kept confined for the first four or five days; the perineal wound should be irrigated twice daily, and the introduction of eusol solution by means of Higginson's syringe (*Fig.* 372) has been found a trustworthy method for this purpose. Irrigation should be commenced as soon as the packing is removed, and persevered with for a fortnight.
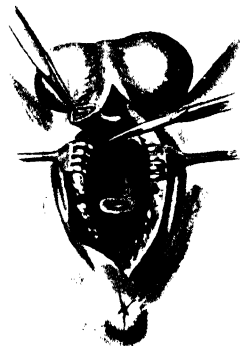
Not until the twelfth or fourteenth day is it necessary to commence instrumentation. Before this is undertaken the meatus should be cleaned up and the urethra irrigated with a solution of 1 per cent
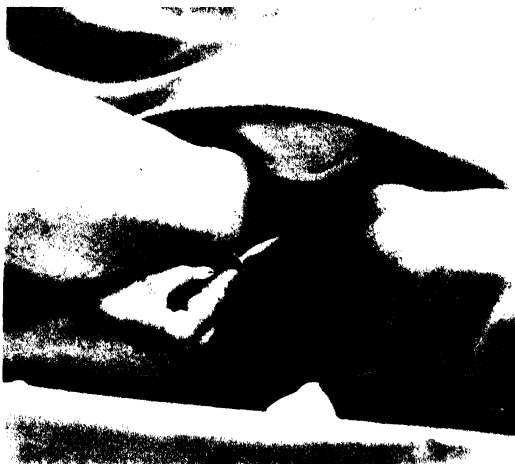
Fig. 372.—Irrigation of the perineal wound with eusol through a Higginson's syringe.

mercurochrome or 1–10,000 solution of silver nitrate. One well-lubricated Lister's sound is introduced, exercising the 'rule of the bougie' —*arte non vi*—to its fullest degree.
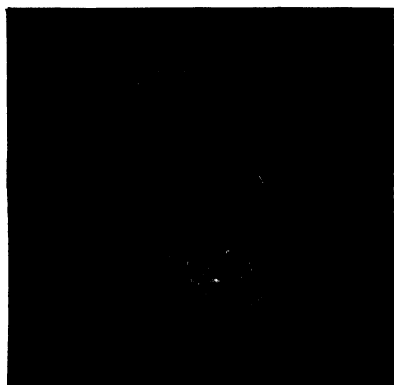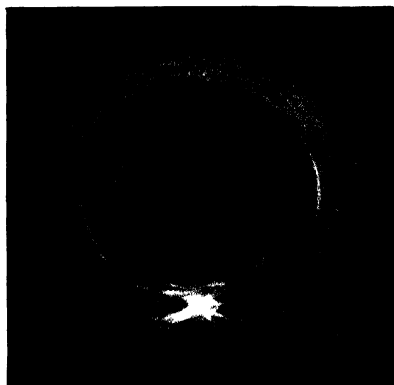
a   b

Fig. 373.—Complete rupture of the bulbous urethra treated by suture of the roof. *a*, Urethroscopic appearance during the sixth week after operation. *b*, Three months later. An irregular scar is seen on the floor. A 17/19 bougie passes with ease.

Frank Kidd laid great stress upon the necessity for urethroscopic control (*Fig.* 373) in the after-treatment of ruptured urethra. Only by repeated use of the urethroscope can we estimate the need or otherwise for dilatation.

Complete Rupture with Extravasation (*Fig.* 374). *The sutureless operation* is without doubt *the* operation when extravasation has occurred, for suturing is technically impossible in the presence of infection or extravasation. If it is attempted under these conditions, the sutures simply cut out and add still further to the destruction and loss of tissues.

Technique. Preliminary suprapubic cystotomy and retrograde catheterization as previously described. The patient is put in the lithotomy position and perineal section performed. A coudé catheter is passed from the meatus into the perineal wound and then threaded through the posterior urethra guided by the retrograde bougie. The perineal wound is left widely open. As Rutherford pointed out, whilst the gap between the ends of the urethra may be considerable when the patient is in the lithotomy position, yet when the legs are extended probably the ends of the urethra will be in contact. Once the catheter is in place it should be fixed in by a stitch through the prepuce or the frænum. Suprapubic drainage of the bladder should be effected by a large rubber tube, and the cave of Retzius should be drained adequately. Incisions are made into the infiltrated tissues as necessity demands.
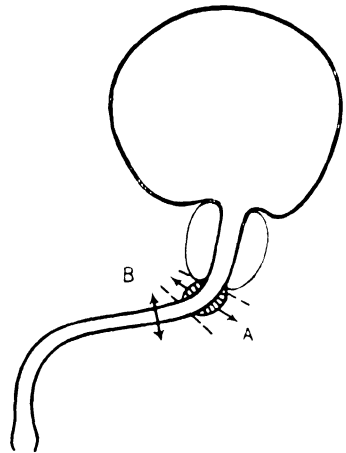
Fig. 374. Extravasation into the cave of Retzius occurs early when the intrapelvic urethra is ruptured; ruptu e of the bulb the reflex spasm of th compressor prevents extrava for many hours. **A.** Extrava early. **B.** Extravasation late.

The catheter should be removed at the end of forty-eight hours, and the after-treatment of the perineal wound is similar to that described in the preceding section. The incisions leading into the extravasated area should be dressed with sterile gauze if non-infected, or, if infected, with eusol fomentations, as described in the section dealing with extravasation following peri-urethral abscess (p. 378).

INTRAPELVIC RUPTURE OF THE URETHRA

Intrapelvic rupture of the urethra is a more serious condition than the foregoing. The mortality is higher, and the immediate diagnosis more difficult. The lesion is almost always an accompaniment

of a fractured pelvis, and shock is often pronounced. In country districts the accident seems to be a characteristic of the hunting field, the horse rolling on the prostrate rider, but in town life street and industrial accidents account for a number of these cases.

Diagnosis.—Signs of fractured pelvis are usually evident. The patient has not passed urine since the accident, and the escape of blood via the meatus is a common occurrence. On examining the abdomen a swelling may be felt in the hypochondrium. Extravasation into the pelvic fascia occurs early, and, curiously, it usually proceeds more on one side than the other (*Fig.* 375). Unless the rounded dome of the bladder can be palpated distinctly from the rest of the swelling (the extravasation), it is impossible, by clinical methods, to establish a differential diagnosis between extra-peritoneal rupture of the bladder and intra-pelvic rupture of the urethra. In this variety of rupture of the urethra there is no perineal swelling, but ecchymoses may be present (Masmonteil).
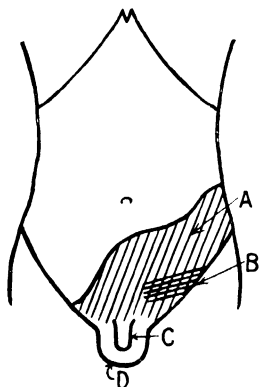
Fig. 375.—Physical signs recorded in a case of intra-pelvic rupture of the urethra complicating a fractured pelvis. **A**, Deep-seated swelling (tender); **B**, Superficial bruising; **C**, Blood from meatus; **D**, Perineum nil. There was grating on compressing the iliac crests.

Treatment.—The investigation of the case should, as in the preceding type, be undertaken in the operating theatre whenever possible. Deansley warns us to be watchful lest the passage of a catheter into the prevesical space, and the withdrawal of a few ounces of blood-stained urine from this situation, be mistaken for an entry into the bladder. This is a trap into which many have fallen.

The operation is commenced by making a suprapubic incision which opens up the cave of Retzius. As a rule only after this has been done is it possible to distinguish between an extraperitoneal tear of the bladder and an intrapelvic rupture of the urethra, and even then, amidst the blood-stained effusion, it may not be easy to determine the exact site of the lesion. The guiding rule is: If the bladder is even moderately distended, the lesion must be situated below the vesical sphincter. Thus the diagnosis of intrapelvic rupture of the urethra is confirmed. (*Figs.* 376, 377.)

The immediate treatment of this accident is often limited to suprapubic cystostomy and drainage of the cave of Retzius. Whilst such a measure commonly saves the life of the patient, it should be emphasized how essential it is to go further and make some provision for the restoration of the continuity of the urethra before it is too late.

THE URETHRA AND PENIS

Intrapelvic rupture of the urethra occurs frequently at the apex of the prostate—in other words, the prostatic urethra is severed from the membranous portion. In addition, the puboprostatic ligaments
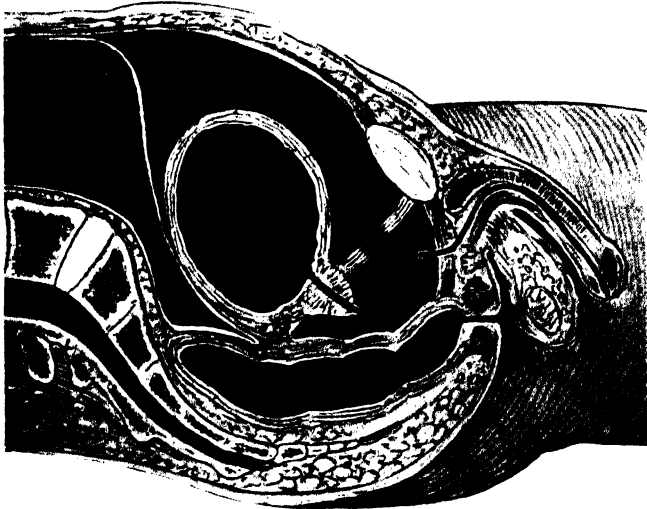
Fig. 376. Intrapelvic rupture of the urethra. The puboprostatic ligaments torn, and the bladder, which may be moderately distended, becomes displaced backwards. (Cf. *Fig. 377.*)
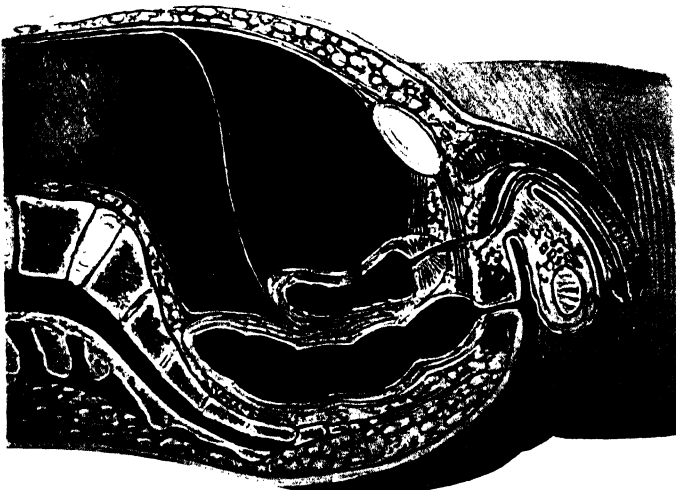
Fig. 377. Extraperitoneal rupture of the bladder. The bladder is empty or practically so. (Cf. *Fig.* 376.)

are torn. The loss of these ligaments, aided no doubt by the pressure of the extravasated products in the cave of Retzius, causes the neck of the bladder, with the prostate, to become displaced backwards (*Fig.* 378). It is this backward displacement which accounts for the hopelessness of remote restoration of continuity of the canal ; and if it is not rectified at the initial operation or very soon afterwards, we are bound to meet with the following depressing aftermath, which is fairly common :—

A boy presents himself with a suprapubic fistula. The sinus is unhealthy and discharging purulent urine. He may have been fitted with a permanent suprapubic belt, but the reason for his appearance is that the fistula has closed down and will not admit the catheter. An examination of the perineum reveals an old scar, and there is a history of a fractured pelvis, rupture of the urethra, suprapubic drainage, and drainage of the cave of Retzius. At a later date (usually when the fracture has united) an attempt—or more often several attempts—has been made to restore the continuity of the urethra, but without success. Continually wet and smelling of urine, subject to recurrent attacks of cystitis and pyelitis, these cases are poignant examples of what Rutherford Morison refers to so aptly as " life-long tragedies ".

Fig. 378. —The mecha n of backward displacement of the bl lder. The urethra having been severed i r the apex of the prostate, and the p prostatic ligaments having been torn, e pressure (arrow) of the extravasated p oducts in the cave of Retzius causes the 1 eck of the bladder to be displaced backwards.

Permanent suprapubic drainage is therefore most undesirable, especially in a young subject. It *can* be prevented, but only by correcting the backward displacement of the neck of the bladder before it becomes anchored in its abnormal position. If this correction is effected at the time of the initial operation or very soon afterwards, there is every hope of restoring the continuity of the urethra eventually.

Methods of Correcting Backward Displacement of the Neck of the Bladder.—

Direct Suture of the Urethra.—It can hardly be said that direct suture of the intrapelvic variety of urethral rupture is very practicable. The patient is almost always shocked—shock is very much more pronounced in this type of rupture than in rupture of the bulbous urethra. We are thus prohibited from attempting a deliberate operation. Direct suture of the intrapelvic variety of rupture must always be deliberate, for it is, at the best, a difficult procedure which must be conducted at the bottom of a deep and hæmorrhagic cavity.

Correction by an Indwelling Catheter. Backward displacement can be corrected by the simple expedient of keeping a catheter along the whole course of the urethra until the bladder neck has become anchored in the anatomically correct position.

Fig. 379. Complete intrapelvic rupture of the urethra. The two fully curved metal catheters or bougies are manipulated until their beaks are indisputably in contact. The instrument on the left is then guided by its fellow into the bladder and the tear in the membranous urethra is bridged.

After the condemnation the indwelling catheter has received in the earlier part of this chapter, it may appear at first sight inconsistent to advocate its use now. I therefore hasten to emphasize

that the principal indication for a retained catheter in urethral injuries is in complete *intrapelvic* rupture. We are dealing here with a grave and desperately urgent accident where simplicity of technique is of paramount importance. Fortunately, it so happens that the very objection to the retained catheter, i.e., its stimulating effect on formation of fibrous tissue, of such great moment in lesions of the bulb, is of practically no account here. *The membranous urethra, unlike the bulbous, shows very little tendency to stricture formation.*
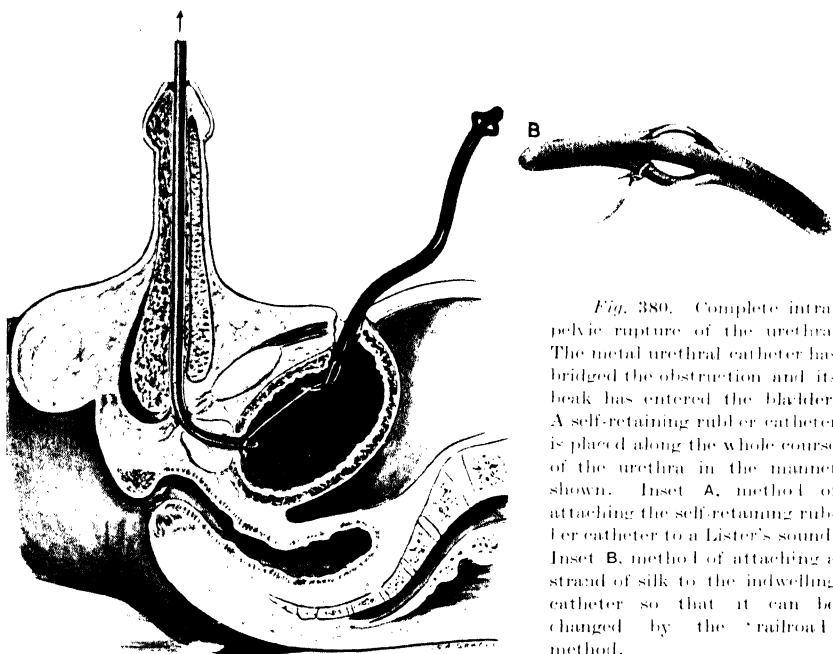
Fig. 380. Complete intra-pelvic rupture of the urethra. The metal urethral catheter has bridged the obstruction and its beak has entered the bladder. A self-retaining rubber catheter is placed along the whole course of the urethra in the manner shown. Inset A, method of attaching the self-retaining rubber catheter to a Lister's sound. Inset B, method of attaching a strand of silk to the indwelling catheter so that it can be changed by the 'railroad' method.

Apart from this fortunate coincidence, the indwelling catheter, in its rôle of correcting backward displacement of the bladder, more than justifies its place as a standard method of dealing with this difficult situation.

Harry Banks's method of dealing with an intrapelvic rupture of the urethra appears to me to be the best that has been devised. Suprapubic cystotomy is performed and a fully curved metal prostatic catheter is passed through the internal meatus along the urethra to the seat of the rupture. Another fully curved metal catheter is passed through the external meatus along the urethra until it comes

m contact with the first. The two catheters are then taken one in each hand and manipulated gently until their beaks lie in contact with one another, end to end (*Fig.* 379). By gently withdrawing the first catheter and pushing the second one farther in, keeping the beaks in contact, it is possible to guide the second catheter past the seat of the rupture and into the bladder. No force is required. The second catheter is made to protrude through the suprapubic opening, and a self-retaining rubber catheter is attached to it by means of a silk thread (*Fig.* 380). The metal catheter is then withdrawn from the external meatus and in this way the self-retaining catheter is drawn into place past the rupture. The opening in the bladder is closed and a drain placed in the space of Retzius. The latter is of great importance, as it permits extravasated blood and urine to escape. The patient is given urinary antiseptics and encouraged to drink plenty of water. Each day after the third day the bladder is gently irrigated with boracic lotion to diminish the formation of deposit on the beak of the catheter. At the end of ten days the self-retaining catheter is removed. This may require an anaesthetic.

While Banks's technique can be followed in its entirety in very early cases, if a delay of more than six hours since the accident has elapsed, I think it

Fig. 381.— Intrapelvic rupture of the urethra. Indwelling catheter brought out through an incision in the perineum.

is advisable to drain the bladder suprapubically with a de Pezzer's catheter. An additional advantage of having a suprapubic drain in these cases is that the indwelling catheter can be changed by the railroad method (*see Fig.* 379). This is a safeguard of the highest importance.

In exceptional cases it may not be possible to engage the tips of the catheters without undue waste of time. Under such circumstances the tip of the retrograde catheter in the perineum may be cut down upon after gently separating the partially flexed thighs. Even in the gravest cases such additional manipulation can add but little to the time and shock of the operation. A catheter can then be passed from the bladder to the perineum (*Fig.* 381) and the posterior end of the urethra is under control.

Case of Intrapelvic Rupture of the Urethra with ? an Intraperitoneal Lesion. A Useful Method of Exploration. The Details of After-treatment Recorded.

E. D., a boy of 12, was admitted in a very shocked condition, having been run over by a motor-car. There was bruising over the hypogastrium, and blood was trickling from the meatus. The abdominal wall was rigid all over, but through this a swelling could be palpated in the hypogastrium, and dullness extended half way to the umbilicus, rather higher on the left than the right. Eric Erichsen's sign for fractured pelvis was positive, and grating could be easily detected. There was no bruising in the perineum.

A diagnosis of probably intra-pelvic rupture of the urethra was made, but, on account of the general rigidity, it was considered possible that there was also an intraperitoneal lesion.

The patient was taken to the theatre, and after the urethra had been washed out with a solution of mercurochrome a soft rubber catheter was introduced. As soon as the deep urethra was entered, a quantity of bright blood passed down the catheter, which could be passed no further. The diagnosis of intrapelvic rupture of the urethra was confirmed. The patient was anaesthetized forthwith, and the introduction of subcutaneous saline commenced. A right para-median incision was made above the pubis, the rectus muscle being split. *The peritoneum in the upper part of the incision was opened, and by this means it was ascertained that there was no blood or urine within that cavity.* Looking downwards into the peritoneal cavity one could see the peritoneum pushed up-

Fig. 382.—I after operation for intra-pelvic rupture of urethra. The suprapubic drainage tube in been connected to a Cathcart's evacuator.

wards by extravasated blood beneath it. The peritoneum was therefore closed and the cave of Retzius opened up. The planes of pelvic fascia were infiltrated with blood and urine, and the bladder was moderately distended. The operation proceeded along the lines already described. The bladder was opened, and a Lister's sound passed down the internal meatus. The thighs were then abducted, and after the skin had been sterilized, the beak of the instrument was palpated in the perineum. A tiny incision in the middle of the perineum exposed the tip of the bougie, which was then withdrawn. A gum-elastic catheter carrying a silk thread was substituted, and its beak was made to protrude through the incision in the perineum.

The catheter was pushed onwards from above until about two inches only lay in the bladder. The bladder was then closed about a de Pezzer catheter, leaving the silk thread referred to hanging out. The rest of the wound was closed with drainage of the cave of Retzius.

The patient was returned to bed, and the foot of the bed was blocked. The de Pezzer was connected to a Cathcart's evacuator (*Fig.* 382). Each day the bladder was washed out with mercurochrome solution. After a week the catheter was changed by the ' railroad ' method. Five days later it was again changed, but this time the catheter was brought out of the external urinary meatus instead of through the wound in the perineum. A week after this it was ascertained that a bougie could be passed from the meatus into the bladder. The patient was anæsthetized with gas for each of these manipulations. Convalescence was uneventful. Several months afterwards a No. 16 French bougie readily entered the bladder, and at the present time the patient is symptom free, although he still attends at regular intervals for the passage of a bougie.

The best results will be obtained after a very early operation. As in the case of rupture of the bulbous urethra, the after-treatment consists in regular dilatation. If in the early days the catheter be changed by the railroad method we are spared much difficulty and anxiety. In one case J. H. Powers found that he could not replace the catheter. He therefore introduced a cystoscope into the suprapubic wound, and by its aid was enabled to pass a ureteral catheter through the internal meatus and thence along the whole urethra.

FOREIGN BODIES IN THE URETHRA

In the male, foreign bodies are usually introduced into the urethra with the object of relieving acute retention. More often than not the foreign body fails to give the desired relief, and we have to perform the dual service of retrieving the object and relieving the retention. In locating the foreign body a radiograph is often valuable (*Fig.* 383). Urethroscopy should be performed whenever possible (*Fig.* 384). By this means the foreign body, if in the anterior urethra, can be seen.

Fig. 383. Hairpin in bulbous and membranous urethra inserted by a patient to relieve acute retention. Removed via a urethroscope obturator.

Many, if not most, foreign bodies can be extracted in the following way. The obturator of the urethroscope is left *in situ*, and a pair

of alligator forceps seizes the foreign body (*Figs.* 385, 386). The obturator, forceps, and foreign body are then removed *en bloc* (*Fig.* 387).
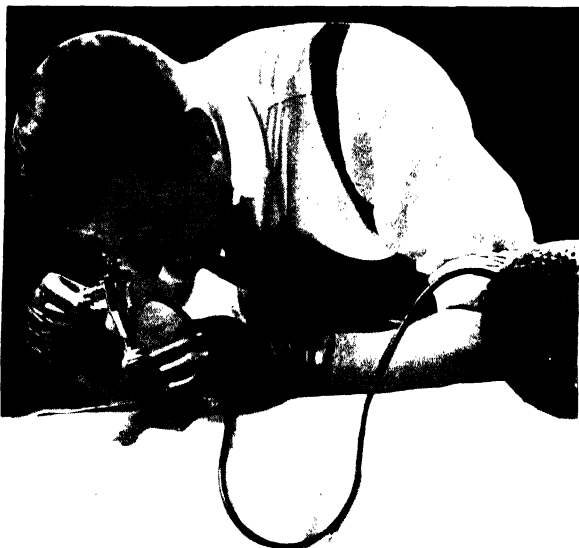
Fig. 384.—Urethroscopy. Swift-Joly's anterior urethroscope being used.
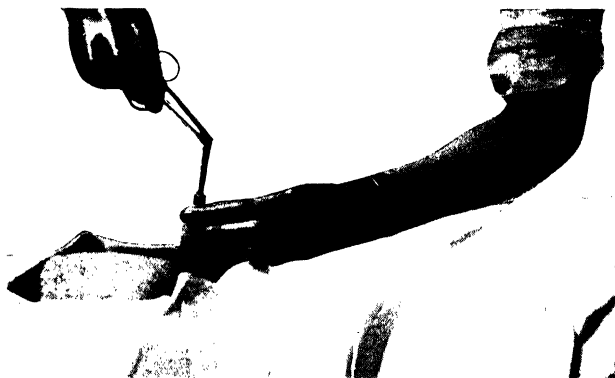
Fig. 385.—Foreign body in urethra. Urethral forceps are introduced through an obturator.

B. G., aged 48, had been drinking heavily one Saturday night, and on getting home found that he was unable to pass urine. Towards morning the pain became intolerable, so, having armed himself with a hairpin, he

went downstairs and proceeded to attempt to get relief. A few hours later he was admitted to hospital with the bladder extending almost to the umbilicus and the hairpin lost within the depths of the urethra. Morphia,

Fig. 386. Alligator forceps

gr. ¼, and a hot bath relieved the retention. After urethroscopy the hairpin was caught with alligator forceps through the obturator of the urethroscope. The forceps, obturator, and hairpin were then extracted together.

Irregular foreign bodies, or those of long standing which have become encrusted with phosphates, are best dealt with by opening the inferior wall of the urethra at the site of the obstruction. After the extraction has been effected, the concomitant infection renders it necessary to leave the lips of the wound widely open.

In the absence of a urethroscope, pins and needles in the anterior urethra may be extracted by angulating the penis in such a way as to make the sharp point of the foreign body protude through the floor of the urethra. In the case of a needle, once the point has protruded it may be extracted immediately; but a pin, on account of its head, must be manipulated so that the head points towards the meatus, into which forceps have been introduced to grasp and remove the pin.

Fig. 387.—Obturator, forceps, and foreign body (a hairpin) removed en bloc.

External Urethrotomy. The indications for external urethrotomy as such will be confined to the removal of foreign bodies and urethral calculi when other methods have failed. As the other methods which have been detailed are almost always successful, the indications for external urethrotomy are necessarily limited.

Technique.—Lithotomy position. Wheelhouse's staff (*Fig.* 388) is passed to the point of obstruction and then rotated, so that the groove lies towards the floor of the urethra. Cutting on to the groove, the urethra is opened and the obstructing agent is removed.

I make no reference to external urethrotomy and Wheelhouse's

GENITO-URINARY LONDON

Fig. 388.—Wheelhouse's staff.

operation in the treatment of acute retention from stricture, for I believe that these cases are better treated by suprapubic catheterization, followed at a later date, when the function of the kidneys has been shown to be satisfactory, by internal urethrotomy.

THE PENIS

Meatotomy.—This is a satisfactory little operation and is not practised frequently enough. Pin-hole meatus and atresia meati are the indications *par excellence* for this measure, but there are many cases in which the meatus is small enough to prevent the introduction of a catheter of satisfactory calibre or the obturator of a urethroscope. A urethral calculus sometimes can be extracted after the meatus has been enlarged.
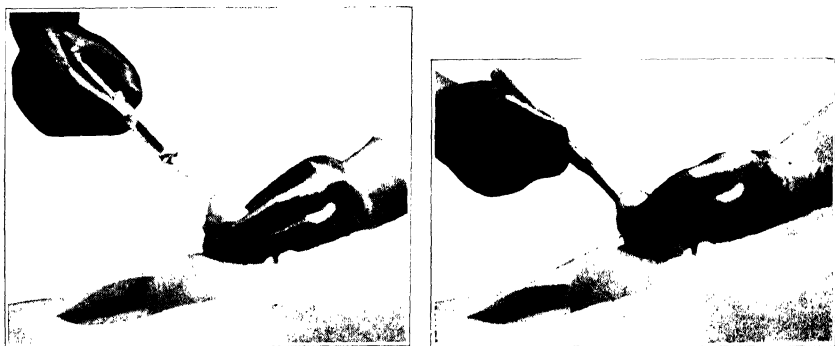
Fig. 389.—Meatotomy. **A,** Novocain being injected just below the meatus ; **B,** A bistoury is inserted into the meatus and a cut is made in a downward direction through the anæsthetized area.

Technique.—Local anæsthetic is introduced with a fine needle into the glans immediately beneath the meatus (*Fig.* 389, A). Quite a small quantity is sufficient, and only one puncture hole is necessary. A bistoury is passed into the meatus with its cutting edge downwards, and with one sharp cut the meatus is enlarged (*Fig.* 389, B). Unless a sound of suitable calibre is passed into the meatus each day for four or five days the atresia will recur.

COMPLICATIONS AFTER CIRCUMCISION.

A troublesome complication after circumcision in the adult is *post-operative priapism*. Bromides, of course, are helpful in allaying erection. In addition, an intelligent patient should be provided with an ethyl chloride spray, which he can apply to the organ as the
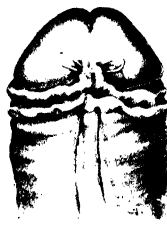
Fig. 390. The ... frænal stitch.

need arises. *Hæmorrhage after circumcision* usually occurs from the region of the frænum. The three-in-one frænal stitch minimizes this untoward occurrence (*Fig.* 390). Further it can be used with

Fig. 392. Method of applying the dressing shown in *Fig.* 391. (*After Schurmeier.*)

area. A vaseline gauze 'tourniquet' (*Figs.* 391, 392) is an excellent dressing. When persistent bleeding occurs after circumcision hæmophilia should be suspected at once and measures must be taken forthwith to supply an adequate amount of prothrombin (p. 686).

Retraction of the skin covering the penis, leaving the shaft bare is not unknown, particularly after the operation where no sutures are used. The condition is remedied by placing appropriate stitches after cleansing carefully the exposed area.

Paraphimosis. Wrap the end of the penis, including the strangulating band, in a pad of cotton-wool soaked in a mixture of 0·1 per cent adrenalin and 10 per cent cocaine. Keep the compress in place fifteen minutes. On removal of the compress, the œdema will be found to have disappeared, and with a little traction the prepuce can be restored to its original position. Circumcise later to avoid a repetition.

The foregoing treatment has reduced the number of cases in which the classical operation—general anæsthetic, nicking the constricting band (*Fig.* 393) in several places, and forcible reduction with the thumbs (*Fig.* 394) will be required.

Acute Balanitis.—Slit up the prepuce with scissors under gas or evipan anæsthesia, and then apply fomentations. Sitz baths are a useful adjunct. A bromide mixture will control priapism, a painful accompaniment of the irritation. Circumcision should be performed only when the inflammation has subsided.

Phagedæna.—Phagedæna is now seen comparatively rarely. The gangrene spreads up the penis, and may involve the scrotum, and even the abdominal wall. The initial lesion is usually a chancre or chancroid, to which is superadded an infection of saprophytic organisms. Labadie emphasizes that the determining factor in the spreading of the gangrene is some form of surgical intervention, notably slitting up the prepuce, and particularly circumcision, which opens up new avenues for the organisms to invade.

Fig. 393. Paraphimosis. Nicking the constricting band. (*After Lowsley.*)

Fig. 394. Two methods of forcible reduction of a paraphimosis. (*After Lowsley.*)

In the first place a conservative line of treatment should be adopted, and it is usually successful, although progress is often slow. Hydrogen peroxide should be used liberally, for the prevailing organisms

are anaerobes. If the glans sloughs, severe secondary hæmorrhage is probable, and to avoid this, partial amputation of the penis in cases where the base is comparatively healthy, or removal of the sloughing area with the actual cautery, becomes necessary. Finally, remember the likelihood of urethral stenosis following the suppuration, and prevent this by passing bougies regularly.

Penile Peri-urethral Abscess. The abscess arises in an infected follicle of Littré, as a complication of acute (rarely chronic) urethritis. A tender induration can be felt on the under surface of the penis. Left to nature, the abscess frequently bursts externally, and a urinary fistula may result. Early incision per urethram is the best method of abruptly terminating these untoward possibilities. The operation is successfully carried out under gas anæsthesia. The help of an aero-urethroscope is desirable; but if the abscess is near the meatus, as it usually is, it may be dealt with by inserting a tenotome down the urethra.

Severe Hæmorrhage from a Urethral Chancre. In the single case of this condition which has come under my notice, a catheter was passed and the penis firmly bandaged. The method proved effective.

Hæmorrhage after Internal Urethrotomy. In a case under my care the hæmorrhage started on the sixth day after operation; it was checked by tying in a catheter. Evidently some of the blood had passed backwards into the bladder, for clots were evacuated when the bladder was washed out. For some days dark, blood-stained urine was passed, but the wash-outs were always soon returned clear. Infection supervened, and the patient died of pyelonephritis. Here was a mistake. Suprapubic cystotomy should have been performed as soon as the bleeding was recognized. Not only would this measure have prevented urine passing over the lacerated tissues, but, what is even more important, all the blood-clot could have been evacuated from the bladder instead of allowing some of it to remain and putrefy, which undoubtedly was the cause of death.

Persistent Painful Priapism. Many cases of persistent painful priapism are due to thrombosis of the deep pelvic veins. It is a recognized complication of leukæmia, and at the preliminary examination do not forget to examine the spleen for enlargement.

Whether the cause of the priapism is neurological or vascular, if erection has persisted for two days thrombosis exists in the corpora, and this thrombosis is sufficient to sustain the erection. The use of sedatives, narcotics, hypnotics, and cooling lotions is absolutely useless. Intraspinal anæsthesia is effective provided thrombosis has not occurred.

The most useful form of treatment, which is applicable to every case, is as follows :—

A point on the skin of the penis about midway down the organ is anæsthetized, and the underlying fascia is injected with local anæsthetic also. An aspirating needle of large size fitted to a syringe is plunged into the corpus cavernosum. On withdrawing the piston dark blood is evacuated (*Fig.* 395). The needle is passed in more deeply and the corpus cavernosum of the opposite side is aspirated. When aspiration has been effected flaccidity occurs. Normal saline is then injected and the priapism reappears. Aspiration and injection are repeated several times in order to wash out the spongy mesh-work, and the organ is left in the flaccid con-
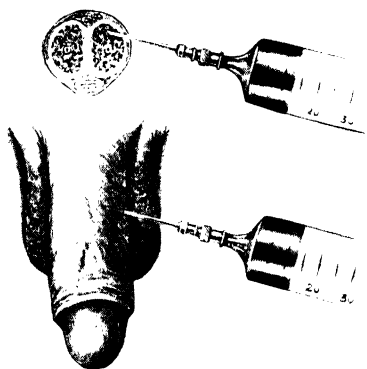
Fig. 395.— Deflating the corpora cavernosa by aspiration.

dition. There is no contra-indication to repetition of the manœuvre at a future time, should it be necessary.

Strangulation of the Penis by Rings.—After a ring has been placed upon the penis venous engorgement follows and strangulation ensues. In early cases the ring may possibly be removed after a compress of adrenalin has been applied. Aspiration of the corpora cavernosa with a needle and syringe may assist by lessening vascular engorgement. When the ring has been on for some time and is firmly embedded, the aid of a locksmith must be sought.

Vermooten describes a case where the offending ring was of thick cast iron and could only be dealt with by an electrically driven circular saw. The saw was applied at two diametrically opposite points, one of which was cut half way through the thickness of the ring, whilst at the other the machine was stopped when it had almost traversed the whole thickness of the iron. The ring was finally severed with a cold chisel and a hammer. Guillot, confronted by a baker with a gold wedding ring firmly impacted upon the penis, used the ingenious method of dissolving the gold in a mercury bath.

Simple homely methods are sometimes useful. When newly appointed as a casualty officer, I was confronted by an excited individual who demanded that a friend in a cab outside should see the doctor alone. Draped in a long cloak, the friend was duly led behind the examining screen. The cloak having been removed, the cause of the excitement was evident, for the patient's penis was

impacted in a stone hot-water bottle, which he supported with his hands. A wet towel having been placed over the receptacle, release was effected by the blow of a hammer.

Fracture of the Penis.—Fracture of the erect penis is a rare but quite definite accident. In cases in which it has been noted there are usually evidences of old-standing peri-urethral fibrosis. Some patients have alleged that they heard a snap at the time of the accident. The organ suddenly becomes flaccid, and excruciating pain is followed by great swelling from the extravasated blood.

The condition should be treated by immediate operation. Through a suitable incision clots are turned out and the corpora cavernosa repaired with sutures. When the corpus spongiosum is the seat of the rupture, in addition to repairing this structure, the torn urethra must be united carefully.

De la Cour and Stephens recorded a case of rupture of the corpus cavernosum which occurred during coitus. The subcutaneous tissue of the penis and the whole of the scrotum were discoloured with extravasated blood. Immediate operation was performed. The tunica albuginea of the left corpus cavernosum was found torn. A large thrombus was lifted out of the cavity in the cavernous plexus. The tunica albuginea was then sutured. Complete recovery and unimpaired function resulted.

In Halloran's case it was the corpus spongiosum which was torn. A man aged 56 noticed sudden pain during coitus. Soon afterwards the penis became swollen, cold, and œdematous distal to an angulation. There were subcutaneous hæmorrhages, and bleeding occurred from the meatus. Halloran made an incision and expressed bloodclot. The torn urethra and corpus spongiosum were then repaired with sutures.

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CHAPTER XXVI

THE TESTIS

ORCHIDECTOMY

ORCHIDECTOMY as an emergency measure should be performed rarely ; so often the testis can be saved. The principal indication for urgent removal of the testicle is torsion when untwisting cannot be effected satisfactorily, or when gangrene has set in.

Technique.—The incision is the same as that used for inguinal herniotomy. The testis having been delivered, the cord is isolated and crushed at a point conveniently distant from the external abdominal ring. The cord is then transfixed and ligatured. To err on the side of safety, it is a good practice to employ two ligatures, one applied a quarter of an inch distant from the other. When the ligatures are securely in place the cord is severed and the testicle removed.

Post-operative Slipped Ligature.—The spermatic cord is a very vascular structure which retracts readily, and insecure ligation of it can prove an unpleasant complication. M. F. Campbell reported a case where fifteen minutes after an operation for varicocele the patient's dressings were found soaked in blood. The wound was re-opened promptly, but the bleeding stump had retracted so far that it was necessary to incise the muscles of the lateral abd(and retract them widely before the proximal venous be retrieved.

INJURIES AND LACERATIONS OF THE TESTIS

Even when the damage is severe, repair is possible, as is shown by the following case described by F. J. Cotton :

A man was hit on the scrotum whilst playing baseball. Excruciating pain and shock resulted, and this was soon followed by the development of an enormous scrotal hæmatoma. The testis was exposed, and, after blood and blood-clot had been swabbed away, a fragmented testis, which looked as if it had exploded under the swift impact, was displayed. The tissues were sewn up layer by layer, and the wound was closed without drainage. The scrotum was supported by light pressure. Convalescence was uneventful.

HÆMATOCELE

Hæmorrhage into the tunica vaginalis may occur as the result of trauma or spontaneously into a pre-existing hydrocele. Absorption of blood from this situation is slow and uncertain. It is better to remove the blood-clot promptly.

The testis can be exposed through an inguinal incision under local anaesthesia, and can be delivered without pain if the cord is infiltrated with 1 per cent novocain just outside the external abdominal ring. Once it is delivered, the tunica vaginalis is incised near its upper pole, and the clot is turned out. The operation may be concluded by turning the hydrocele sac inside out (Jaboulay's operation), or one of the other operations for the radical cure of a hydrocele can be performed.

Great attention must be paid to haemostasis, for if the slightest oozing occurs a scrotal haematoma is liable to develop. After all operations upon the testis, scrotum, and inguinal canal, in order to minimize dead space, it is a good practice to support the scrotum firmly by bandaging or adhesive strapping.

Post-operative Scrotal Hæmatoma.—The long wait necessary for absorption to take place and risks of infection of massive blood-clot can be obviated by evacuating promptly the blood and blood-clot in the following manner. After suitably infiltrating the overlying skin with local anaesthesia towards its most dependent part, the over-full scrotum is punctured with a trocar and cannula. Through the cannula the blood-clot is broken up and washed out with normal saline introduced by a syringe attached to a lumbar puncture needle. Afterwards the scrotum is elevated and compressed by strips of adhesive. It seems customary to adopt an expectant attitude in these cases, which are not rare. Since adopting this simple measure I have been gratified with the results, and particularly with the hastening of convalescence.

ACUTE EPIDIDYMO-ORCHITIS

It is unwise to jump to a conclusion that acute epididymo-orchitis is necessarily gonococcal. An attempt should be made early to isolate bacteriologically the infecting organism. In the first instance all will agree that treatment should be expectant. The patient is confined to bed with the inflamed organ and its fellow supported on a bridge of adhesive (*Fig.* 396). B. W. Turner recommends ice applications for the first forty-eight hours, and if the pain and swelling begin to subside, heat is substituted for ice. Under this régime the majority of cases subside.

In Britain, operation for acute epididymo-orchitis is seldom undertaken at present, unless, of course, a subcutaneous abscess forms. There can be little doubt that a too conservative attitude in these cases is a cause of unnecessary suffering, recurrence, chronicity, and male sterility. Turner's views on the matter are sound. If the pain and swelling have not commenced definitely to subside by the third or fourth day, the advisability of carrying out the following procedure should receive attention.

The area is shaved as far as possible, and the skin is prepared with picric acid, for iodine irritates the scrotum. Turner advises local anæsthesia, but in my cases I have found the parts too tender and inflamed for successful infiltration, and consequently have given a spinal anæsthetic, which answered admirably.

Fig. 396. — A splint for the testicles. Broad adhesive plaster is employed to make the sling.

Operation.—*The organ is explored through a lateral incision in the outer surface of the scrotum*, exposing the entire epididymis and cord for two inches.

Fig. 397.—Incision for decompression of the epididymis. (*After R. W. Turner.*)

Step 1. After an incision through the coverings of the testicle, such as that shown in *Fig.* 397, the epididymis is freed from adhesions and the cord separated from its bed. The vas is exposed and a hollow needle inserted into its lumen. By means of the needle acting as a cannula the vas is catheterized with a strand of silkworm gut. If the vas is patent and no pus exudes, its sheath is closed with a catgut suture. *If pus is present*, the silkworm gut is left in place and brought out through the skin at the upper angle of the wound.

Step 2.—When a secondary hydrocele sac is present it is incised. This is done through a simple longitudinal incision at a point opposite the epididymis.

Step 3.—An incision is made over the entire epididymis (*Fig.* 398), which is separated from its sheath by blunt dissection. The epididymis is probed systematically with a sharp instrument in search

of an abscess. A piece of rubber drain is inserted and the sheath united over the drain (*Fig.* 399). The wound is closed and the drains removed upon the third or fourth day.

The immediate relief of pain which follows decompression of the epididymis and the subsequent rapid convalescence prompts one to recommend wholeheartedly this operation in severe cases of epididymo-orchitis, particularly those where the infecting organism is the *Bacillus coli*.

In cases of *acute gonococcal epididymo-orchitis* of moderate severity very favourable results are reported from the use of a 7·5 per cent solution of calcium chloride administered intravenously. The chief
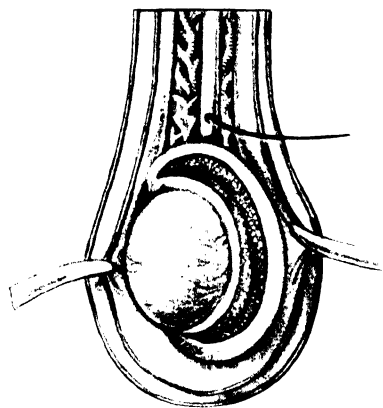
Fig. 398. The epididymis has been incised. A strand of silkworm gut is placed in the lumen of the vas to drain pus therein.
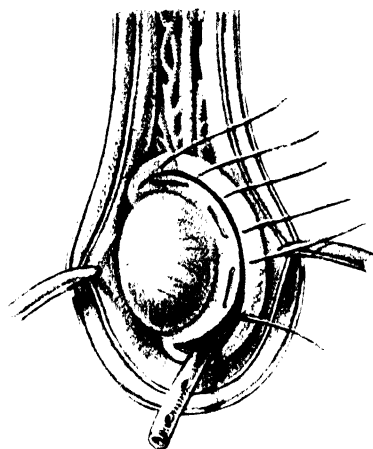
Fig. 399. Closing the epididymis with drainage.

symptom following the injection is a sense of heat all over the body, but this lasts only a few moments, and no other untoward symptoms have been reported. Often within twenty-four hours the inflamed painful testicle begins to assume a normal appearance. Curiously, the urethral discharge is quite unaffected. Two drachms of calcium chloride are dissolved in 1 oz. of distilled water (this is the stock solution); 2 c.c. of this are boiled in a test-tube and drawn into a sterile 10-c.c. syringe, into which freshly prepared normal saline is added up to 7 c.c. The contents of the syringe are then injected intravenously, very slowly. In many cases only one injection is necessary to produce a gratifying improvement, but in the majority of cases several injections are necessary at intervals of between two and five days.

ACUTE EPIDEMIC FUNICULITIS

Acute epidemic funiculitis is due to a streptococcal thrombo-phlebitis of the pampiniform plexus. An acute hydrocele is a regular accompaniment. The general symptoms are often grave, and unless surgical treatment is resorted to early, death results from septicæmia. Operation is imperative before the fourth day if death is to be averted. The operation recommended by Bird is to open freely the tunica vaginalis and separate the constituents of the cord, leaving the wound open. This disease is rare. Epidemics of this curious disease have occurred in Egypt and India, but it is unknown in Europe.

TORSION OF THE TESTIS

Torsion of the testis, perhaps more accurately called torsion of the spermatic cord, occurs relatively frequently in maldescended organs. It has been my experience that it is the fully descended testis which is somewhat more often affected. The factors which favour torsion are illustrated in *Fig.* 400, and it is clear that torsion occurs seldom, if ever, in a normal
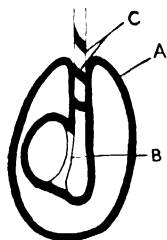
Fig. 400. - Diagrammatic representation of the predis-posing causes of torsion of the spermatic cord. A, Complete and high investment of the testis, epididymis, and cord by the tunica vaginalis ; B. Testis and its adnexa hang in the vaginal cavity like a clapper of a bell ; C. The cremaster muscle, which is attached spirally, will readily cause rotation of the clapper when it contracts vigorously. (*After Muschat.*)

testis. Consequently, if untwisting is feasible, pre-cautions should be taken at a convenient time to fix the testis by sutures in an anatomically correct position (*see Figs.* 403 404).

Torsion of the Fully Descended Testis.—This may be a dangerous diagnosis --dangerous if it conveys the suggestion of something which does not require an immediate operation. A case which I have in

EXT. ABDOMINAL RING

TENDER ŒDEMATOUS CORD
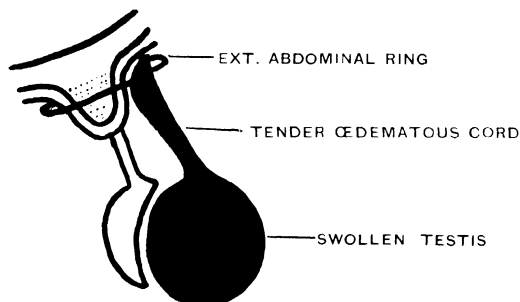
SWOLLEN TESTIS

Fig. 401.—Explanation of how a small strangulated hernia may cause testi-cular symptoms by pressure on the cord.

mind was diagnosed as torsion of the testis by virtue of the engorged, tender cord, the swollen testis, and the small secondary hydrocele; but when the case came to be operated upon a gangrenous Richter's hernia was found in the inguinal canal. This had pressed upon the cord at the external abdominal ring and accounted for the testicular symptoms (*Fig.* 401).

Sometimes when the patient is not seen until six or more hours have elapsed and gangrene of the testis has set in, an erroneous diagnosis of acute epididymo-orchitis is apt to be made. for the scrotum becomes slightly inflamed and the temperature registers about 99° F. *Fig.* 402 illustrates a case in point. If the patient present-ing these symptoms is a box, and recent mumps is excluded, it is far more likely that the symptoms are due to torsion of the testis or of its appendages (*see below*), for acute epididymo-orchitis at this time of life is, apart from mumps, exceedingly rare.

When the diagnosis of torsion is tolerably certain and the patient is seen early in the attack, manipulation should be attempted.

Fig. 402. Torsion of the testis in a boy of 14. The inflamed acutely tender right testis and scrotum simulate acute epididymo orchitis exactly.

R. E. Smith's Case:—

On Oct. 17, 1933, a schoolboy at Rugby was awakened at 5.30 a.m. with excruciating pain referred to a point one-third along a line joining the anterior superior iliac spine to the umbilicus. He was very restless, and writhing in agony at 6.45 a.m. The right testicle was of the size of a hen's egg, and moderately tender. On rotating his testicle 180 from his left to right he volunteered the statement, "That's better". but it required a further 180 before complete relief was obtained. He was left to hold the testicle in position for an hour. Three hours later the testicle was normal in size.

In later cases, or when manipulation is not quickly and entirely satisfactory, the testis should be exposed through an inguinal incision. The skin is best prepared with picric acid, for iodine burns and irritates the skin of the scrotum. The operation can be conducted readily under a local anaesthetic, especially if a preliminary dose of morphia has been given, or evipan can be used. The testis is delivered through the wound. If, on untwisting the cord, there are any signs of a return of the circulation, an attempt should be made to preserve the organ and to fix it by sutures in an anatomically correct position. *Figs.* 403 and 404 will make clear how this can

be done.   Experience teaches us that in the majority of instances
when untwisting has been performed after the sixth hour atrophy
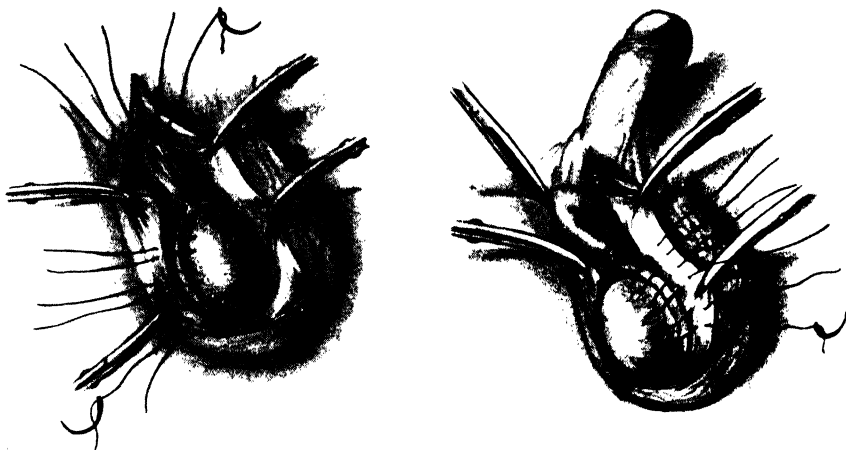
Figs. 403, 404.— Method of anchoring the testis with sutures to prevent recur-
rence of torsion.   The left-hand figure shows lateral mattress sutures, the right-
hand medial mattress sutures of the septum dartos.   The sutures are passed in
each case through the tunica albuginea.   Fine silk or thread is perhaps the best
material to employ in order to make the anchorage permanent.

of the testis ensues eventually, although it takes several months
to become manifest.   Therefore, if the testis appears blue-black and

lifeless, the best course is to
ligate the cord securely and
remove the useless organ.

**Torsion of the Maldes-
cended Testis.**— It   is   often
difficult, if not impossible, to
distinguish this from a strang-
ulated hernia.   True, the cor-
responding side of the scrotum
is empty and the possibility of
the testis as a cause of the
painful tender lump in the in-
guinal region springs to our
minds.   Notwithstanding, the
lump in question often turns
out   to   be   a   strangulated
hernia, for is not a hernia a
fairly regular accompaniment

Fig. 405.— Torsion of a maldescended testicle
removed from case quoted in the text.

of this anomaly? There should be no hesitation in exploring the swelling promptly.

B. A., aged 14, for some years had a lump in his right groin. For three days it had been larger and painful, and he had vomited two or three times. On examination there was a large irreducible right inguinal hernia. The testicle on the left side was absent, and the patient had hypospadias. The hernial sac was opened and was found to contain a testis black in colour. The cord was twisted three times. This was untwisted, but there appeared to be no life in the testis. Orchidectomy (*Fig.* 405). Herniotomy. Recovery.

TORSION OF THE APPENDAGES OF THE TESTIS AND EPIDIDYMIS.

Vestigial structures related to the testis and epididymis—namely, the hydatids of Morgagni, the paradidymis or organ of Giraldés, and the vasa aberrantia—are liable to undergo axial rotation. The commonest of these structures to twist is the pedunculated hydatid (*Fig.* 406). Colt reported the first case in 1922. V. W. Dix has collected forty-two cases reported in the literature.

Torsion of the appendages of the testis is essentially a lesion occurring before, or at the age of, puberty. No doubt many cases have escaped recognition and have been looked upon as examples of epididymo-orchitis of unknown origin. Apart from the orchitis of mumps, acute epididymo-orchitis is of the utmost rarity in young boys, whereas torsion of the appendages of the testis cannot be so exceedingly unusual, for Mouchet in France, who has been interested in this condition for some years, has personally operated upon thirteen cases. Therefore, if a boy gives a history that one side of the scrotum has become swollen following a sudden attack of pain, torsion of an appendage of the testis should at once occur to the mind of the diagnostician. Treated expectantly, the affection runs a rather painful course, accompanied often by pyrexia, but resolution occurs eventually in all cases. Im-

Fig. 406.— Torsion of the pedunculated hydatid of Morgagni. (*After Foshee.*)

mediate operation with ligation of the pedicle and amputation of the twisted appendage terminates the symptoms abruptly.

IDIOPATHIC GANGRENE OF THE SCROTUM
(*Fournier's Gangrene*)

Idiopathic gangrene of the scrotum arises without apparent cause, and the progress of the disease is always the same—first involvement of the scrotum, then extension along those planes so well

known in urinary extravasation. The entire scrotal coverings slough, leaving the testes, bared to their tunica, hanging exposed though remarkably free from gangrene. In H. Brunn's case the gangrenous portion of the scrotum was excised and large incisions were made into the infected inguinal region. Potassium permanganate dressings were applied, and irrigations of a 1–6000 solution of potassium permanganate were instituted at regular intervals through Dakin's tubes. Polyvalent anti-anaerobic serum was also given. Under this treatment the infection subsided, and seven weeks later secondary suture was performed, after which the wounds healed per primam.

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CHAPTER XXVII

THE THORAX

THE PLEURAL REFLEX

Sudden death has followed the insertion of a hollow needle into the pleura for diagnostic purposes in a sufficient number of instances to warrant its very serious consideration. The pleural reflex appears to occur via the vagus. Infiltration with novocain before inserting the needle is a good practice. It not only renders exploratory puncture painless, but definitely minimizes the risk of this alarming catastrophe. Cessation of the heart-beat thus caused should be the occasion to attempt resucitation by an intracardiac injection of adrenalin, followed if necessary by cardiac massage.

ASPIRATION OF THE CHEST

The entry of air into the pleura at the time of aspiration is to be avoided rigorously, for it favours collapse of the lung and spread of the infection. If the simple apparatus shown in *Fig.* 407 was employed as a routine the possibility of air entry would be abolished entirely.
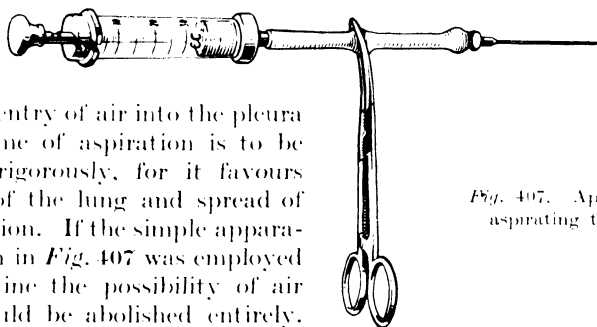
Fig. 407. Apparatus for aspirating the chest.

ACUTE EMPYEMA

An important question in the treatment of empyema is the *time* at which the operation is performed. If thoracotomy can be delayed until the aspirating needle withdraws frank pus, really thick* 'laudable' pus, resection of a rib and drainage gives highly satisfactory results.

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* In order to avoid ambiguity as to what is meant by 'thick' pus some of the aspirated fluid should be placed in a test-tube and allowed to stand for twenty-four hours. At the end of this time, if it is really thick pus, eight- or nine-tenths will be solid.

An experience of empyema during the 1918 influenza epidemic convinced me that rib resection in the presence of merely thin, blood-stained, semipurulent fluid was attended by an appalling mortality. Soon after the operation the circulation appeared to become flooded with a dose of toxin with which the patient was unable to deal. " During an active pneumonia with all the vital forces of the patient mustered in resistance, even a minor operation may be followed by true surgical shock. The removal of a portion of rib may cause battering impulses along the nerve routes that serve to break down the resistance of a system that is already swaying in the balance " (Griffin).

Young children below the age of 5 stand rib resection badly. The mortality in very young patients is too high to warrant continuance of this method ; intercostal drainage offers a better prospect. On the other hand, for most empyemata occurring in older subjects, drainage by rib resection under local anæsthesia remains a highly satisfactory procedure, carrying a low mortality and a good end-result. Local anæsthesia must always be the method of choice, for, when one lung is functioning but feebly, it is obvious that inhalation anæsthesia would be dangerous.

Technique of Drainage by Resection of a Rib. Twenty minutes before operation the patient should have a suitable dose of morphia.

Position of the Patient. —This is important. He should lie on the unaffect-

Fig. 408. The prone position for an empyema operation.

ed side with the arm supported, or, as I have found highly satisfactory, in the prone position (*Fig.* 408). The prone position is comfortable for the patient, and, when working with a local anæsthesia, ideal for the operator.

Selection of the Rib to be Resected.—The angle of the scapula is palpated *with the arm by the side* (*Fig.* 409). The rib immediately below this point is the most suitable for resection. If the rib *above* this point is selected, the scapula will act as a shutter and consequently impede drainage. If a rib *below* this point is chosen, the chances of inadvertently performing a transthoracic laparotomy are much greater than might be expected. One often hears that the lowest possible true rib should be chosen. This is bad teaching. I have on three

occasions been called urgently to advise concerning omentum or other abdominal contents which had appeared in the wound whilst an operation for empyema was in progress. I have heard of the kidney being exposed in an endeavour to drain the pleural cavity at the lowest point possible. Therefore *choose, not the lowest true rib, but one just clear of the scapula.*

When all is in readiness for the operation, when the skin has been painted and towels are in position, the selected rib is found by palpation, the arm, as just noted, being by the patient's side. With

Fig. 409.—In selecting the rib most suitable for resection in empyema—i.e., that immediately below the angle of the scapula—the arm must be by the side (A). The level of the scapula when the arm is raised is shown at B.

the finger still marking this point the arm is held out of the way and there maintained throughout the operation. Infiltration with 1 per cent novocain is begun.

Resection of a Rib under Local Anæsthesia.—The skin over the rib is anæsthetized for about four inches. The subcutaneous area is then infiltrated widely (*Fig.* 410). One pauses for a few moments to massage the œdematous tissues with a swab. The incision is made and deepened; bleeding points are ligatured. It should be noted that the act of crushing the vessel with the ligature is painful. The varying amount of muscle encountered is infiltrated and divided. The periosteum is now in view, and the time is ripe

for the crucial point in anæsthetization—viz. the perineural injection of the intercostal nerve. The needle is passed under the lower margin of the rib as far back as possible - i.e., near the angle of the rib so that its point lies in the intercostal groove (*Fig.* 411). Of the structures in the intercostal groove the nerve lies lowermost, and so is within easy reach. The anæsthetic fluid should be infiltrated slowly here. The periosteum is supplied largely from the intercostal nerves of the rib above and the rib below : therefore secondary infiltrations are made about the lower edge of the rib above and the upper edge of the rib below.

Fig. 410.—Empyema. Infiltrating the subcutaneous tissues with local anæsthetic.
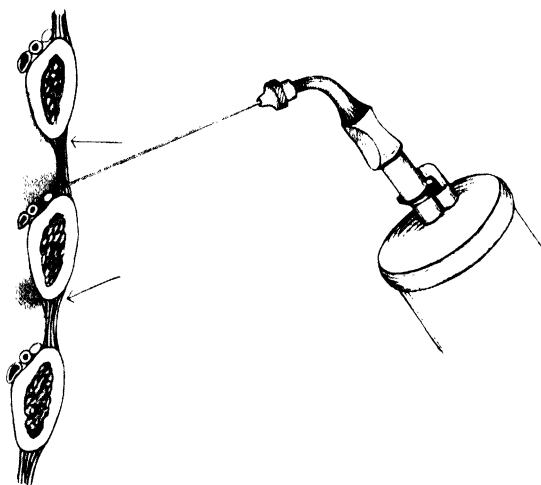
Fig. 411. —Infiltration of local anæsthetic prior to rib resection. The needle is passed into the intercostal space. Note that the nerve is the lowermost structure in this space. The subsidiary areas of infiltration referred to in the text are also shown, indicated by arrows.

The whole length of the exposed periosteum is incised. Using the elevator (*Fig.* 412), the periosteum is peeled off to the edges of

the rib. Doyen's raspatory is introduced under the periosteum, and sweeping around the upper border of the rib, its beak is made to protrude subperiosteally at the rib's lower edge. Sliding the instrument to and fro, the periosteum is stripped from the internal surface of the rib (*Fig.* 413). The raspatory comes to rest at the anterior end of the rib and

Fig. 412. Resection of a rib. Stripping the superficial aspect of the rib of periosteum.

serves as a guide for the rib shears. Rib shears such as the pattern illustrated (*Fig.* 414) minimize wounding vessels and the pleura. The rib is resected in the limits of the incision. This is the only painful part of the operation. Some state that it is not pain that disturbs the patient, but the sound of the section of the bone. In any case, it is necessary to warn the patient to keep steady, and this stage of the operation is carried

Fig. 413.—Rib resection. Stripping the periosteum from the internal aspect of the rib with a Doyen's raspatory.

out as expeditiously as possible.

The portion of rib having been resected, sinus forceps are plunged through the pleura and their blades opened

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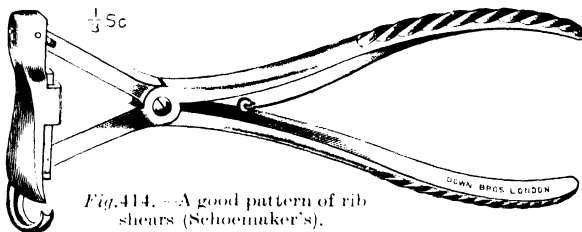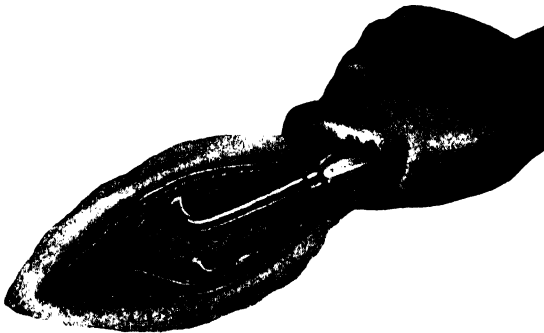
*Fig.*414. — A good pattern of rib shears (Schoemaker's).

(*Fig.* 415).   Quickly a finger explores the interior ; gross adhesions in the immediate vicinity of the opening may be broken down, but there is no need to forage about in the pleura systematically ; indeed,
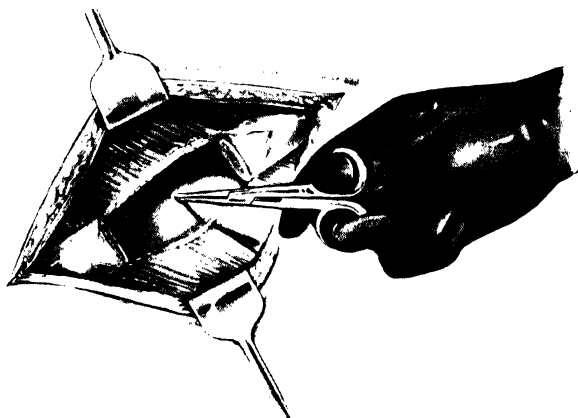
Fig. 415.—Opening the pleura.   A slight upward tilt is given to the better to avoid he diaphragm.

this is to be disparaged.   A gauze swab placed over the opening at this juncture prevents pus being shot into the face of the operator.   The patient is rolled slowly almost on to his back to allow the escaping pus to be collected in a receptacle ; often a mass of purulent fibrin—a semi-solid coagulum— must be helped through the exit.   This is accomplished

by grasping it delicately with sponge holding-forceps.   This jelly-like material is friable, but it can be extracted by employ-ing a light touch with the sponge holder at the correct moment, which is at the zenith of expiration.   When as much pus as possible has drained away, the patient is rolled back
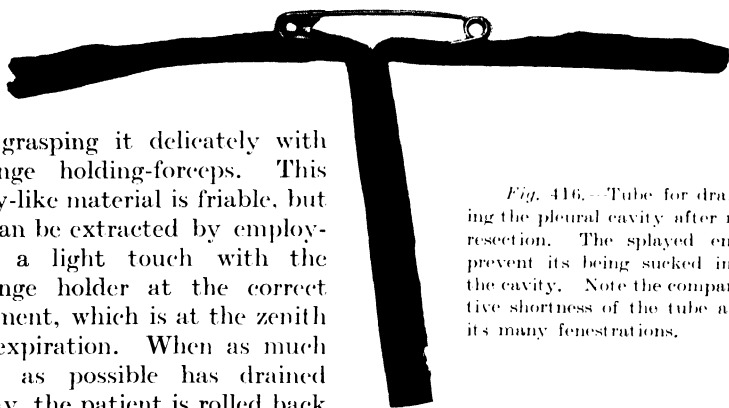
Fig. 416.—Tube for drain-ing the pleural cavity after rib resection.   The splayed ends prevent its being sucked into the cavity.   Note the compara-tive shortness of the tube and its many fenestrations.

into the prone position.   A drainage tube is inserted—a good pattern is shown in *Fig.* 416, for it is impossible for this to be sucked into the pleural cavity.   The tube should be short and have many fenestrations.

Lilienthal has shown the fallacy of the long tube. This fallacy will be appreciated by a reference to *Fig.* 417.

Ample dressings are applied. Hot-water bottles are packed around the patient so as to maintain warmth during his journey from the theatre to bed.

After-treatment — The tube should be turned after forty-eight hours, and gradually shortened. It is not usually advisable to remove it for a week. The patient is encouraged to expand his lungs by blowing water from one Woulfe's bottle to another (*see* p. 314).
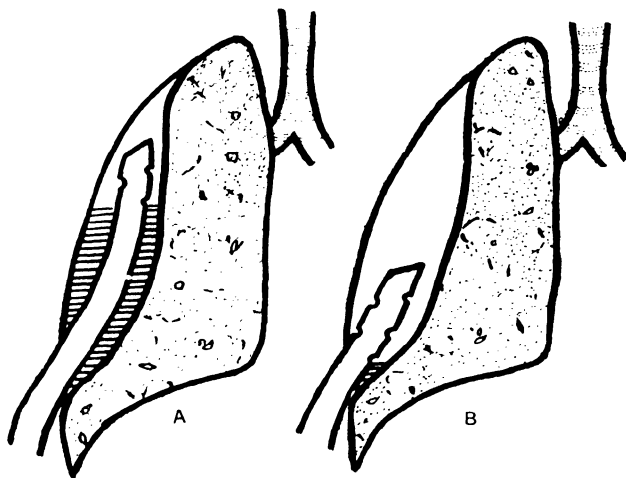
Fig. 417. **A,** The fallacy of using a long tube in the pleural cavity; **B,** A short tube with many fenestrations completely drains the cavity. (*After Lilienthal.*)

I performed the operation as outlined above in a consecutive series of 42 serious cases. Forty recovered. Of the two fatal cases, one was a man of 66.

Regarding *irrigation of the cavity*, Dakin's solution or eusol is employed by some surgeons. I think it is a mistake to commence irrigation early—that is before the fifth day—for the movement exhausts the patient, and there is a possibility of flushing the infection to a higher level. The only patients who have succumbed or have given rise to anxiety when I confidently expected a smooth recovery, have been patients whose empyema cavities have been irrigated. Personally I have given up irrigation after thoracotomy with rib resection. If the surgeon feels that irrigation is desirable I think he should do it, or supervise its being done, himself, as obviously considerable extension of the infection can follow forcible or otherwise unskilled pleural douching.

At the present time views as to the best method of treating an empyema are conflicting. The somewhat old-fashioned method of open drainage appears to be thoroughly sound, providing it is not used in young children. For the latter the closed method of treatment is infinitely better.

Some Complications of Empyema Operations and their Management.—

*Hæmorrhage from the Intercostal Artery.—*Bleeding coming from under the cover of the cut edge of the rib may be alarming. It is usually futile to attempt direct ligature, for the arterial wall is fragile and the artery itself most inaccessible. The following method of stopping the hæmorrhage will be found to be of great service, and it is always reliable.
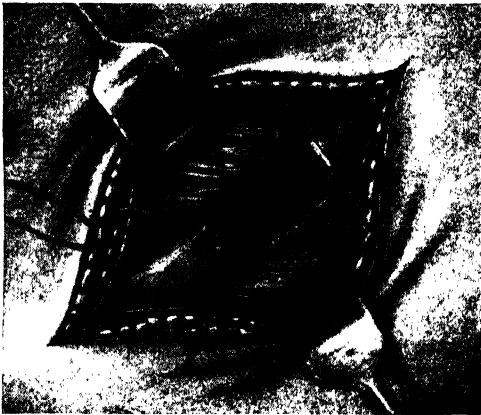
Fig. 418.— Hæmorrhage from an intercostal artery. Method of passing the ligature around the rib.

If there is only a small portion of rib showing, extend the incision backwards. There should be about three-quarters of an inch of rib available. Take the largest curved needle, armed with a stout ligature, and pass it round the rib so that the point emerges in the intercostal space below (*Fig.* 418). By this means a ligature is thrown around the rib. A finger is passed into the wound and so manipulates the ligature that an adequate loop is present on the under surface. Into this loop a small roll of gauze is inserted. After it has been ascertained that the gauze lies snugly within the loop, the ligature is drawn tight and tied. A length of the gauze should be left protruding from the wound. The artery is thus compressed against the bone by the gauze within the loop (*Fig.* 419) and the hæmorrhage is controlled. At the end of forty-eight hours the gauze may be removed by cutting the ligature.

When the intercostal artery has been wounded, it is usually the result of using Liston's straight bone-cutting forceps. If the rib shears shown in *Fig.* 414 are employed, the frequency of the accident is reduced.

*Transpleural Laparotomy has been Inadvertently Performed.—*In most cases the opening into the pleura has been made too low. Pus has not been struck, for the empyema is an encapsuled one not

extending into the lowest part of the pleural cavity, otherwise the accident is unlikely to have occurred. The very fact that pus has not been found leads the operator to think that the pleura is still unopened, and so mistaking the diaphragm for thickened pleura, he plunges into the peritoneal cavity.

Once the mistake is recognized, precautions must be taken to ensure that the pus sac is not opened until the repair of the diaphragm has been effected. On one occasion I was summoned hurriedly to the operating table where a mass of great omentum was presenting in an empyema wound. The omentum was stitched to the lower edge of the wound in order to occlude the opening in the diaphragm. The rib immediately above having been resected, the empyema was opened. The patient made an uninterrupted recovery. In most instances, however, the best practice is to sew up the hole in the diaphragm, using a small needle on a holder. This is not difficult, and rarely does harm result.

The Rib which has been Resected is too High or too Low; it is Thought that Drainage will be Inadequate. — Resect a second rib immediately adjacent. The anaesthesia, of course, must be attended to, but the resection of a second rib does not take long.

The Pleura has been Opened, but no Pus has been Found. — It goes without saying that the operation would not have been undertaken if the aspirating needle had not withdrawn pus. First of all explore with the finger.

Fig. 419.—Diagram showing the method of controlling haemorrhage from an intercostal artery.

Possibly the empyema is a localized one and a loculus may be entered. After this has been done with a negative result, the possibility of a lung abscess or an interlobar abscess must be considered. At this juncture, on two occasions I punctured the lung with an aspirating needle and found a large abscess cavity, which was drained successfully by employing the technique described on p. 431.

THE CLOSED METHOD OF INTERCOSTAL DRAINAGE

The closed method of intercostal drainage is to be employed as a routine in young children, say, under six years of age. In older subjects this method should be confined, I think, to desperately

urgent cases where the patient is too ill to be moved and drainage
has to be effected as he lies in bed. Such cases are rare because a
patient who is too ill to be moved should, as a rule, be treated by
simple aspiration.

As before, the *time* at which the operation is performed is of
fundamental importance. From the Children's Hospital, Winnipeg,
comes the following excellent aphorism, " When the organism present
is a pneumococcus THICK pus must be present for a week before
drainage is undertaken ; when the organism is the streptococcus
THICK pus must be present for at least ten days " (McEachern).
Simple as is the operation, its success depends upon minute attention
to detail.

The Rehearsal. —What may be termed the rehearsal can be done
in the seclusion of your study whilst you are seated in an armchair.
Nevertheless, it is truly the most important part of the procedure.

Procure a No. 16 or 18
rubber catheter and a
trocar and cannula.
The cannula must be of
such a size that the
selected catheter just
passes along its lumen.
A close fit is essential.
Also take a pair of scis-
sors with you. Sit down.
Pass the catheter down
the cannula and once
more make sure that it
is a tight fit. Cut off
the bulbous tail-piece ;
the catheter can now
pass right through the
cannula. Cut a second
eye half an inch from

Fig. 420.—The rehearsal. When the point X reaches
the mouth of the cannula 1¼ inches of the catheter
should project from the distal end of the cannula. A
secondary eye has been cut.

the terminal eye. One and a quarter inches only of the catheter
must project into the pleura ; allow this much of the catheter to
protrude from the end of the cannula. Mark this point by taking
a tiny chip from the side wall of the catheter with scissors, but
make this mark where, when the all-important moment arrives, you
will be able to see it clearly (*Fig.* 420). We will call this point ' X '.

The Operation.—Select the correct intercostal space and apply
a piece of ice to numb the skin. Inject local anæsthetic. Make an
incision very slightly longer than the diameter of the cannula. Drive
the trocar and cannula into the pleura, but not far. Remove the

trocar; almost as a reflex the left index finger is placed over the mouth of the cannula. This prevents pus coming out, or what is more important, it prevents air being sucked in. The catheter, duly clipped with a hæmostat (*Fig.* 420), with its nose moistened with paraffin, is taken in the right hand which waits and seizes the opportunity to pass the catheter into the mouth of the cannula directly the left index is removed. When the mark ' x ' is reached the cannula is drawn out of the chest. Before removing the hæmostat a second hæmostat is placed on the catheter, this time proximal to the cannula. We have now placed a catheter in the pus-filled pleura without allowing air to enter the thorax. Then comes the important stage of sealing the incision about the catheter.

Sealing the Incision : McEachern's Technique. This is accomplished by applying successive layers of absorbent cotton-wool to which collodion is applied with a brush until a collar, five inches in diameter and half an inch thick, is built up about the tube. In order that this dressing may adhere firmly to the skin and adjacent catheter these parts must be clean and dry. This is brought about by washing them carefully with ether. To begin the application of the dressing a layer of collodion is applied to the skin with the brush. A thin layer of cotton-wool is then laid on this base and smoothed out with the brush, which has been dipped in the collodion. This ensures good cohesion between the dressing and the skin. By the application of successive layers of cotton-wool in a similar manner the dressing is built up to the required thickness. The dressing will remain tight longer if the catheter is held immovable in the chest wall. This is accomplished in the following manner : when the dressing is about half applied a small round needle threaded with a double strand of silk is passed through the wall of the catheter (without entering its lumen) flush with the surface of the dressing. This double thread is then cut, leaving the ends about two inches in length. Another thread is then passed through the opposite wall of the catheter in a similar manner. These threads are embedded in the dressing as it is completed and effectively prevent movement.

To ensure that the dressing will not be disturbed in moving the child back to bed, it is fanned for twenty minutes before the patient is moved from the operating table. The child is then returned to bed with the clamp still on the end of the catheter. To allow the dressing to set more firmly this clamp is left in position for three hours longer. The catheter is then connected with the drainage apparatus (*see* p. 430), when the clamp is removed, and the pus drains into the bottle. If the effusion is large and the surgeon wishes to decompress the lung slowly, this can be done by removing and applying a clamp at intervals.

Fig. 422. Inter-
costal drainage of an
empyema in a small
child by the closed
method, with suction
apparatus.

Fig. 421. Intercostal drainage of
an empyema in an infant. The catheter
has been connected up with a bottle
containing antiseptic solution.

DAKIN'S SOLUTION

ABSORBENT COTTON
AND COLLODION
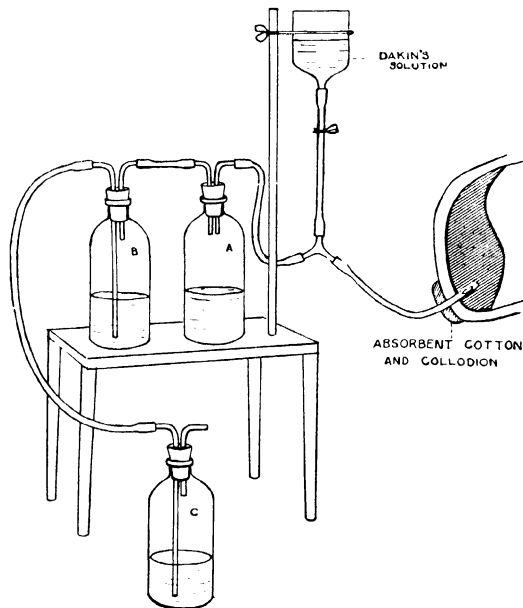
Fig. 423. Closed drain-
age in empyema. To irrigate
the cavity the rubber tube
connecting the Y glass con-
nection with bottle A is
clamped, after which the
clamp is removed from the
tube connecting the Y with
the container for Dakin's
solution; when the abscess
cavity is filled the solution is
clamped off and the clamp
between the Y connection
and bottle A removed, allow-
ing the solution to drain off
by suction into bottle A.
To remove the solution
accumulated in bottle A
clamp both rubber tubes
leading from the glass con-
nections in the cork; the
cork may then be withdrawn
and the bottle emptied with-
out disturbing the siphon.
Bottles B and C are inter-
changeable. When bottle B
is nearly empty place a
clamp on the rubber tubing
between bottles A and B and
another clamp in the tube
between bottles B and C;
the bottles are then changed,
placing the empty one on
the floor and the full one on
the table (McEachern).

Apparatus for Closed Drainage. To lead the tube through the cork into antiseptic lotion in a bottle (*Fig.* 421) has served me well. If the apparatus is at hand Cathcart's evacuator provides mild suction and is also a good method (*Fig.* 422). McEachern prefers irrigation with Dakin's solution. His apparatus is illustrated and described in *Fig.* 423. His results using this method have been unequalled.

ABSCESS OF THE LUNG

Lung abscesses following pneumonia are nearly always peripheral and usually involve the visceral pleura. In emergency surgery a lung abscess is usually encountered unexpectedly. The thorax is opened in the belief that there is an empyema, pus having been

Fig. 424. Opening an abscess of the lung. The first stage consists in marsupialization of that portion of the lung containing the abscess.

(*After A. L. Lockwood.*)

found with the exploring needle. At the operation no pus is found within the pleural cavity, but the exploring finger comes upon an indurated area in the lung. Suspecting lung abscess, a needle is inserted, and pus is found.

Leave the needle in position. As a rule it is wise to resect a second rib. With the needle still in position marsupialize the abscess

by stitching the intercostal muscles and pleura to the lung surrounding the periphery of the abscess (*Fig.* 424). If space permits the skin can be also stitched to the marsupialized area, thereby making doubly sure that the exposed portion of lung overlying the abscess is completely shut off from the pleural cavity. It is usually wise to defer opening the abscess for at least 2 or 3 days. By this time adhesions have formed, walling off the pleura, and the abscess is opened with the point of a cautery.

WOUNDS OF THE LUNG AND PLEURA

Hæmothorax from Laceration of the Lung.—There is still undue reluctance about opening the thorax in necessary cases. Thoracotomy to arrest hæmorrhage is analogous to laparotomy for ruptured ectopic gestation. Even in patients who are almost moribund operation can be undertaken with a reasonable hope of success. The steps of thoracotomy for hæmorrhage will be given by citing an actual case.
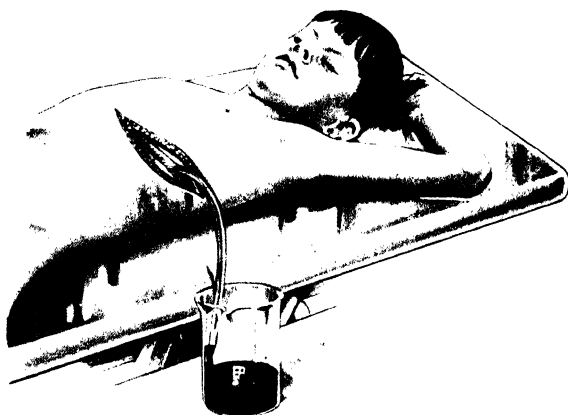
Fig. 425.—Hæmothorax. Collecting the blood for auto-transfusion.

A boy of 10 fell from a tree. He was admitted to the Royal Northern Hospital some hours later, pale and dyspnœic, complaining of pain in the left side of the chest. Respirations were laboured and rapid. Both anteriorly and posteriorly the left side of the thorax was dull up to the level of the third rib. An X-ray examination revealed a fracture of the sixth rib and showed that the left side of the thorax was full of fluid. Aspiration was performed and pure blood was withdrawn. In spite of morphia and rest his

condition became critical, and he was hurried to the operating theatre. A skilled anaesthetist was available. so he was given gas and oxygen. In other circumstances local anaesthesia would have been employed. A long incision was made between the sixth and seventh ribs (*see* *Figs.* 425 and 427) exposing the intercostal muscles, and towels were clipped to the skin edges. A large catheter was then inserted into the pleural cavity through a cannula, and blood flowed down the catheter. The blood was collected in a jug containing citrate solution. After a pint and a half had been collected the operation was continued. By a sweep of the knife through the intercostal muscles, the pleura was opened. The sixth and seventh costal cartilages were divided with the scalpel, the internal mammary artery being ligated. A mechanical retractor having been inserted, the interspace was opened widely. The heart could be seen beating quite strongly within the pericardium, which was reassuring, for at the commencement of the operation the radial pulse was barely perceptible. Some blood was still in the pleural cavity ; this was mopped up with an abdominal pad.

Suture of the Lung.—The collapsed lung being seized with a Denis Browne's forceps, the lower lobe was drawn out of the wound (*Fig.* 426). A lacerated wound was seen at once and sutured. The
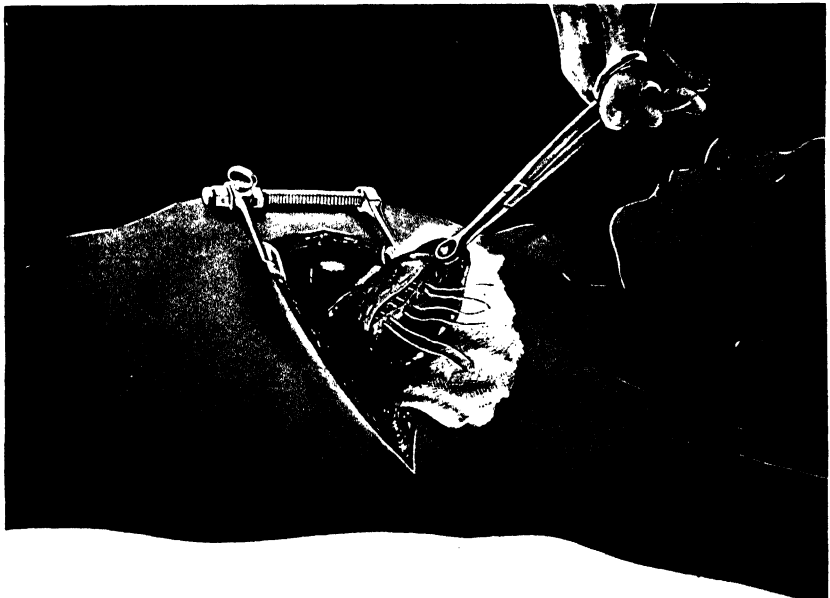
Fig. 426.—Suturing a wound of the lung.

sutures held well—the lung is not nearly as friable as, for instance, the liver. A small bleeding point could be seen in a tear of a reflexion of the pericardium on to the diaphragm. This was attended to by under-running the bleeding point with a ligature on a needle. Hæmostasis now appeared complete. The last traces of blood and blood-clot were removed from the pleura with swabs on a holder.

Closure of the Thorax.—The mechanical retractor was removed and the ribs fell together; they were approximated snugly by inserting loops of catgut around them with a large curved needle. Before tying these sutures a catheter was placed in the inferior angle of the wound. The skin was then closed tightly with a running suture.

Obliterating the Pneumothorax.—A bladder syringe having been connected to the catheter, as much air as possible was aspirated from the pleural cavity; the catheter was then clipped with a hæmostat.

The patient after being wrapped up warmly was transferred to bed.

Auto-transfusion.—The blood which had been collected was admixed with saline and given by the continuous method. The first pint and a half was run into the vein comparatively quickly.

Post-operative Treatment.—The next day the patient's condition was satisfactory. Breathing exercises with a Woulfe's bottle were ordered. The catheter was removed on the fifth

Fig. 427.—Thoracotomy for ruptured lung. The patient convalescent. To show the extent of the incision.

day. The lung soon expanded, and convalescence was uninterrupted (*Fig.* 427).

Penetrating Wound of the Lung (e.g., stab or bullet wound).—The only modification of the foregoing technique is that both the parietal and the visceral wound should be excised with scissors. If there is a retained foreign body, it is removed. Whenever possible, drainage of the pleura should be avoided.

'**Open Thorax**' (wounds opening freely into the pleural cavity).—It is of the utmost urgency to close the thorax. The wound is excised thoroughly, and cleansing of the pleural cavity is undertaken in necessary cases.

Needle Broken off in the Thorax.

I was asked to see a young man whose doctor gave the following history. The patient had had pneumonia, and empyema was suspected. A hollow needle was inserted, and while the syringe was being adjusted the patient gave a violent cough. The needle broke, and about three inches was left in the chest. An X-ray showed the needle in the lower part of the chest above the diaphragm. Choosing the point of puncture as a guide, I resected two adjacent ribs under local anæsthesia. On opening the pleura the needle could be seen penetrating the diaphragm and moving to and fro with its excursions. The needle was readily seized and removed. The lung appeared to be in a state of red hepatization, and did not collapse very much when the pleura was opened. The wound was therefore closed without drainage. A hollow needle was then inserted just beneath the incision and as much air as possible aspirated. The patient made an uninterrupted recovery.

Fig. 428. —Traumatic asphyxia.

TRAUMATIC ASPHYXIA

Traumatic asphyxia sometimes follows compression of the thorax. It has been noted particularly after crushing consequent upon panic in crowded spaces. Thus, six cases were admitted into the Bellevue Hospital, New York, after the cry of 'fire' had been raised in a neighbouring picture palace (Bruce Robinson).

The condition presents a remarkable clinical picture (*Fig.* 428). The face is purple and the cyanosis extends down the neck on to the thorax, finally fading off about the level of the fourth rib. The conjunctivæ are bright red from subserosal effusion of blood. In severe cases there is loss of consciousness, and it may be necessary to perform artificial respiration. Usually all that is required is to prop the patient up in bed, administer oxygen, and order a cardiac stimulant.

SURGICAL EMPHYSEMA

Surgical emphysema is usually a complication of fractured ribs, but it may occasionally be met with in other conditions. For instance, I have seen severe subcutaneous emphysema follow the introduction of subcutaneous saline where air has got into the supply tubes.

Fig. 429.—Incisions used for surgical emphysema. Photograph four months later. (*Douglas and Morton : from ' Annals of Surgery ', by kind permission.*)

Minor degrees of surgical emphysema require no treatment, and usually absorption takes place in a few days. When the area involved is considerable, and particularly when it is spreading, there should be no hesitation in opening the subcutis under local anæsthesia and letting out the air (*Fig.* 429). This simple and effective method is not resorted to early or often enough.

MEDIASTINAL EMPHYSEMA

Mediastinal emphysema is a condition associated with a constant escape of air into the mediastinum, such as may occur in wounds of the trachea, bronchi, or even the œsophagus. In severe cases the neck and face become suffused and livid (*Fig.* 430), the lividity arising from pressure on the great veins at the root of the neck. The condition threatens life, and calls for prompt treatment.

Fig. 430. Mediastinal emphysema.

(*Tiegel : By kind per*

Fig. 431. Mediastinal emphys after treatment.

of Messrs. Saunders.)

Make an incision in front of the infrathyroid portion of the trachea. Ligaturing vessels as they are encountered, deepen the incision right down to the trachea. Improvise some form of suction to the wound. The air can be gradually withdrawn, and relief usually follows. In Tiegel's case (*Fig.* 431) two days of continuous suction was necessary. When the escape of air is from the upper part of the trachea tracheotomy will be indicated, and this will prevent further leakage into the tissues.

ACUTE MEDIASTINITIS AND MEDIASTINAL ABSCESS

Superior Mediastinitis.—An incision in the suprasternal notch as described in the case of mediastinal emphysema, combined with suction, often acts admirably.

Anterior Mediastinitis.– Through a ⊣-shaped incision to one side of the gladiolus (*Fig.* 432) the third costal cartilage is resected, which gives fair access to this cellular space. If there is a localized
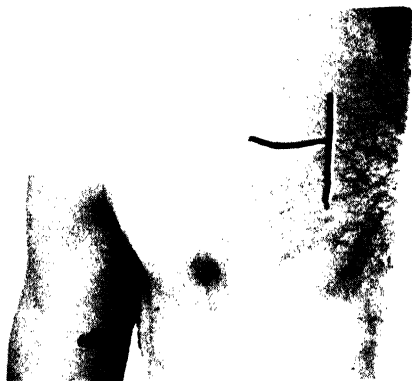
Fig. 432. –Incision for exposing the anterior mediastinum. The third costal cartilage is resected.

collection of pus, the wound may be enlarged, removing an adjacent costal cartilage if necessary (*Fig.* 433).

Fig. 433. Drainage of the anterior mediastinum. (After Lilienthal.)

Posterior Mediastinitis.— The posterior mediastinum can be approached without entering the pleura. Lilienthal advises a paravertebral incision curving outwards towards its lower end from the fourth to the ninth rib. The ninth rib is resected within the limits of the incision, the skin flap being retracted as far as possible. When resection of this rib has been completed the finger is carefully inserted between the posterior unresected part of the rib and its periosteum, and this membrane and the pleura are carefully peeled away from the posterior chest wall. Soon the pleura will be found to be separated from
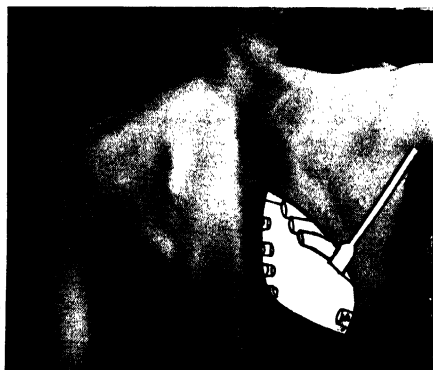
Fig. 434. –Exposure of the posterior mediastinum. The ninth rib is resected. The eighth, seventh, and sixth are divided near their posterior extremity, and retraction is exerted as shown in the figure.

the eighth rib. This rib is then divided near its posterior extremity, but not resected. Still proceeding in the same manner, the seventh and the sixth ribs are similarly treated. The stripping becomes easier as we proceed upwards and backwards, the pleura being very readily swept aside. With a broad retractor under the eighth rib, retraction is exerted in the direction of the corresponding shoulder and a good exposure of the posterior mediastinum is obtained (Fig. 434).

WOUNDS OF THE HEART

While the majority of wounds of the heart prove fatal before surgical aid is available, the heart is not the fragile organ it was once supposed to be; if the patient lives to be transported to a surgical service, suture of the cardiac wound offers a very fair prospect of a successful issue. The results of non-operative treatment are extremely poor compared with those of a well-chosen operation. Of 152 cases of operation for injury to the heart and pericardium, 48 died and 104 recovered (Ballance).

The ventricle is more frequently wounded than the auricle. Auricular wounds in particular are very liable to produce *heart tamponade* (Fig. 435). Heart tamponade implies a muffling and compression of the heart produced by the increasing hæmopericardium. If the wound is small, heart tamponade may take hours to produce its lethal result. Even in moribund cases the heart may sometimes begin to beat when the pericardium is incised.

Fig. 435. Heart tamponade — bleeding into the pericardium gradually compressing the heart. The condition occurs more often after wounds of the auricle.

Suppurative pericarditis, due usually to organisms introduced at the time of the wounding, is more to be feared than the shock of exposing and suturing the heart. Time employed in sterilizing the skin of the thorax with iodine is well spent.

Protruding needles should be removed at once. Larger objects, such as *knives or daggers, must not be taken out until the operation is ready to commence,* for fear of severe external hæmorrhage.

Special Instruments and Apparatus which are Advantageous.—

1. As in all thoracic operations, if intratracheal anæsthesia is available, so much the better.

2. A cotton glove for the left hand, to be worn over the rubber glove, is helpful when holding the heart during the stage of 'palming' (Lilienthal).

3. A strong mechanical abdominal retractor is desirable. If no mechanical retractor is available. a third assistant is essential.

4. Six curved needles carrying tested ligatures are laid in readiness on the instrument table before the operation is begun.

5. Rib shears and nibbling forceps (for sternum) should be at hand. but are seldom necessary.
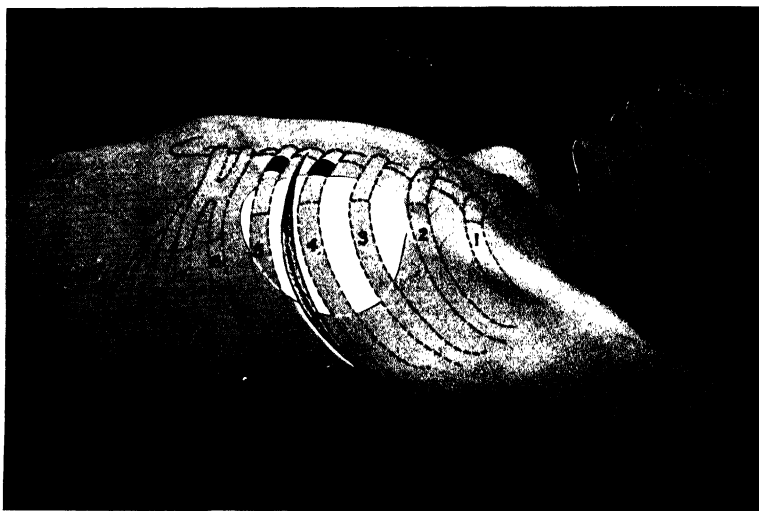
Fig. 436. -S   incision.

Spangaro's method of exposure (*Fig.* 436) offers advantages. chief among which are the speed with which it may be performed and the fine exposure obtained. This incision allows a concomitant wound of the lung, or hæmorrhage from the heart into the pleura. to be dealt with.

Operation.—A long incision is made into the fourth intercostal space. If the stab wound is in the third or fifth space this would be chosen instead. The intercostal muscles are divided. The fourth and fifth costal cartilages are isolated, and are divided near the sternum. If more room is required. the third and the sixth costal cartilages may be divided. The mechanical retractor is introduced and the pericardium is in full view. The wound in the pericardium is enlarged with scissors ; instantaneously the left hand darts in to compress the beating heart. The heart should be held in the peculiar manner known as 'palming' the organ. The thumb and index finger remain in front and compress the edges of the wound ; the middle, ring, and little fingers are behind the ventricles. By 'palming', the motions

of the heart become much less violent. The wound is now closed by passing the sutures previously threaded (*Fig.* 437). These are tied by an assistant. When the wound is situated on the posterior surface of the heart, the organ must be dislocated. A suture is passed through the apex, and the heart is gently delivered from the pericardium (*Fig.* 438). When the wound is closed securely the heart is allowed

Fig. 437. Suturing a wound of the heart.

to fall back into place,* and the pericardium is sutured, with or without drainage according to judgement. The rib retractor is removed, and the wound closed by deeply placed skin sutures.

After the operation has been completed intravenous saline, and often a blood transfusion, is indicated. Convalescence is usually

* Cardiac massage has been employed successfully in several instances where the operative manipulations have caused temporary cessation of the heart-beat.

stormy ; minute emboli may be thrown off from the sutured wound and lodge in the lungs. Pneumonia is a common complication. In order to minimize the occurrence of emboli some recommend that the suture material should be of paraffin-coated silk.

R. Warren's Case.—

A male, aged 48, fat and flabby in build, had been stabbed over the heart four hours previously. A small linear wound ¾ in. long (which did not appear to be deep) was found over the precordium, while external bleeding was minimal. The patient complained much of pain over the heart, was pale and anxious, with a small feeble pulse of 120 ; the area of cardiac dullness was perhaps slightly increased, and the heart-sounds were but no adventitious sounds were heard. From the position of the wound and the amount of shock a diagnosis of hæmopericardium was made. The pericardium was explored by turning up a flap of soft parts and removing the cartilages of the fourth and fifth left ribs with half the sternum opposite these. The intercostal and internal mammary vessels were tied and the triangularis sterni was displaced. The pericardium was tense, dark in colour, and the cardiac impulse obscured. The pericardium was freely opened, much blood escaping, and a wound 1¼ in. long in the anterior surface of the right ventricle was secured with catch forceps and sutured with five stitches of silk. The pericardium and skin were then sutured. The wound healed by first intention. With the exception of slight left pneumothorax (due to tearing the pleura at the exploration) and a little femoral thrombosis, convalescence proceeded uneventfully. The patient was demanding work a year afterwards, and three years later was alive and active.

Fig. 438. Dislocating heart.

C. H. Peck's Case.—

A girl, aged 24, was brought to the Roosevelt Hospital in an ambulance, having been stabbed in the chest with a pocket knife about half an hour before her arrival. Peck happened to reach the hospital at almost the same moment, to call on another case, and he saw the patient within five minutes of her admission. There was no radial pulse, but a weak pulse varying in force and volume with each inspiration and expiration could be felt high in the brachial and in the carotids. The heart-sounds could not be heard. Respiration was faint and shallow, the extremities cool, and the patient in profound shock. The area of cardiac dullness was increased, but no attempt was made to map it out accurately. There was a stab wound at the left border of the sternum over the third costal cartilage with very little external hæmorrhage. The patient was taken at once to the operating theatre. The pericardium was exposed and opened, and about 300 c.c. of dark blood escaped with a gush. The degree of heart tamponade had been extreme, but directly the tension was released the anæsthetist noted a return of the radial pulse. The bleeding seemed to come from the

upper right portion of the pericardial sac, but the rapidly beating heart churning the free blood made it impossible to locate the wound until a transverse cut into the pericardium to the right gave better exposure ; then, by lifting the heart forward with the left hand and rotating it slightly to the left, a wound of the right auricle was brought into view. With each systole a stream of dark blood spouted two or three inches. The wound was closed by interrupted catgut sutures. The pericardium having been emptied of blood and blood-clot with the hand and gauze sponges, the pericardium and the wound were closed without drainage. An intravenous saline was given on the table. For the first six or seven days there were signs of pleurisy in the left chest. The wound healed by first intention and the patient made an absolute recovery.

PERICARDIOTOMY FOR PYOPERICARDIUM

Purulent pericarditis does not respond to medical treatment ; yet there still exists a curious antipathy towards pericardiotomy, in spite of the fact that it is attended by results comparable to those obtained by the drainage of pus from the pleural cavity. Winslow and Shipley had 6 recoveries in a series of 10 patients.

Fig. 439. —Pericardiotomy by the transsternal route. Opening the pericardium. (*After Winslow and Shipley.*)

Fig. 440. — Pericardiotomy by the trans-sternal route. Suturing a drainage tube into position.
(*After Winslow and Shipley.*)

Pericardial puncture should not be done to confirm the diagnosis. The danger of paracentesis pericardii is greater than that of an exploratory operation; moreover, it has been noted on several occasions that the exploring needle has failed to locate the pus, and consequently an otherwise well-established diagnosis has been upset. "Paracentesis pericardii should be banished from surgical practice" (Ballance).

Trans-sternal Pericardiotomy.—The trans-sternal route offers the following advantages: (1) The operation can be performed readily under local anæsthesia; (2) The internal mammary artery is not encountered; (3) That area of pericardium devoid of pleural overlap is exposed.

Technique.—The integument overlying the gladiolus and xiphisternum is infiltrated with local anæsthetic. Using the smallest trephine or a Doyen's burr, the sternum is trephined immediately above the gladiolo-xiphisternal junction. The opening is enlarged with nibbling forceps, especially to the left of the middle line. That triangular area of pericardium which is uncovered by pleura is exposed, and made more obvious by gauze dissection. The pericardium is now ready to be opened. A fine, curved needle on a holder picks up its fibrous layer, and the scalpel, held almost flat, opens the sac (*Fig.* 439). The opening is enlarged and the finger inserted. Drainage is effected by a soft, preferably split, rubber tube (*Fig.* 440). The importance of recognizing and treating an associated empyema, primary or secondary, cannot be exaggerated.

TRENDELENBURG'S OPERATION FOR PULMONARY EMBOLUS *

Pulmonary embolism is often so swiftly fatal that any form of treatment is out of the question. In other cases, where the embolus is small, the victim mercifully escapes death without any special treatment. There is yet another group where the patient in a desperate condition is still holding on to life when examined, but death follows in a matter of minutes or hours in spite of cardiac stimulants and oxygen. Trendelenburg sought to save these patients by opening the pulmonary artery and removing the clots. This surgical pioneer did not live to see the fruit of his labours. For many years Trendelenburg's operation was condemned as unjustifiable by medical and surgical authorities alike, but his pupils continued their master's work. At the German Surgical Congress in 1924, Kirschner, of Königsberg, presented a patient who had survived pulmonary embolectomy. Kirschner, who followed Trendelenburg's technique in every detail, was the first surgeon to save by operation a patient with pulmonary

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* The late Professor A. W. Meyer of Berlin kindly lent many of the illustrations reproduced in this section.

embolism. In 1927 A. W. Meyer, of Berlin, reported two further successful cases, and in 1930 the same author was able to announce
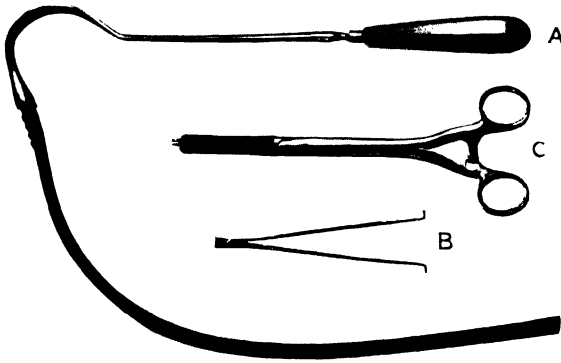
Fig. 441. —Trendelenburg's original instruments. **A,** Tourniquet, with introducer; **B.** Forceps for everting the edges of the incision into the pulmonary artery; **C,** Rubber-covered clamp applied to side of artery while incision is closed.

that a total of seven patients lectomy.* Reports such as these must give renewed impetus to surgical enterprise.

Special instruments (*Figs.* 441, 442, and 451) are essential. These are comparatively inexpensive. If one is armed with these instruments and the knowledge of how to use them, many lives should be saved.

The Time to Operate.— It is comparatively simple to judge when the operation should be performed—this is when the patient is dying. The procedure is not, as might be thought, necessarily an immediate one. Often the surgeon must sit waiting by the bedside for hours ready to operate at a few moments' notice should it appear that life is ebbing.

d recovered after pulmonary embo-
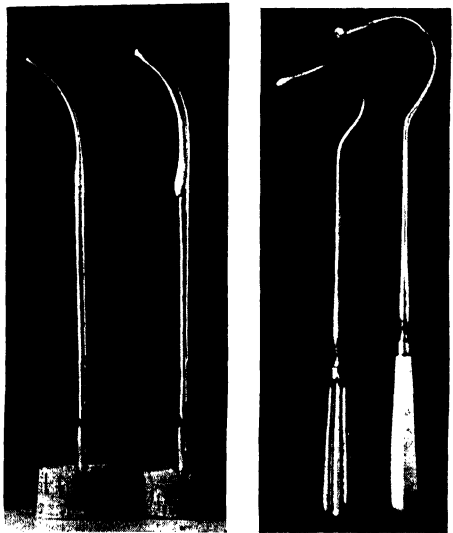
Fig. 442.—Original Trendelenburg forceps and sound, and Meyer's modifications. The left-hand figure in each picture is the improved pattern of instrument. The forceps are covered with gauze instead of rubber. (*A. W. Meyer.*)

* Several more successful cases have been reported subsequently.

Technique.—Meyer's modification of Trendelenburg's operation is adopted. Meyer has improved Trendelenburg's instruments (*Fig.* 442). Since one is operating upon the dying, the preliminary stages

Fig. 443.—Incision for Trendelenburg's operation for pulmonary embolus.

of the operation are bloodless.* The incision is a ⊢-shaped one. The vertical limb keeps close to the left border of the sternum from below the clavicle to about the fourth costal cartilage. The horizontal limb lies between the second and third ribs (*Fig.* 443). The second and third ribs are laid bare and freed from their periosteum quickly (*Fig.* 444). These ribs with their attached costal cartilages are then excised (*Fig.* 445). great care being taken to avoid opening the pleura. The forefinger now gently pushes its way beneath the medial part of the

Fig. 444.—The raspatory is introduced close to the sternum at the cartilaginous portion of the second and third ribs. (*A. W. Meyer.*)

fourth rib (*Fig.* 446). The pericardium, shining white and partly

* If the patient is still conscious a small quantity of general anæsthetic is administered. In successful cases anæsthesia must be resorted to during repair of the thoracic wall.

covered with fat, is plainly in view. The pericardial sac is picked
up with dissecting forceps and incised, and pericardial fluid flows
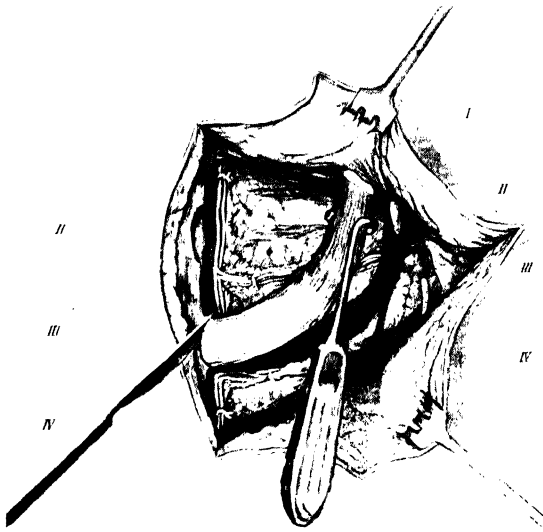
Fig. 445.—Excision of rib. (A. W. Meyer.)
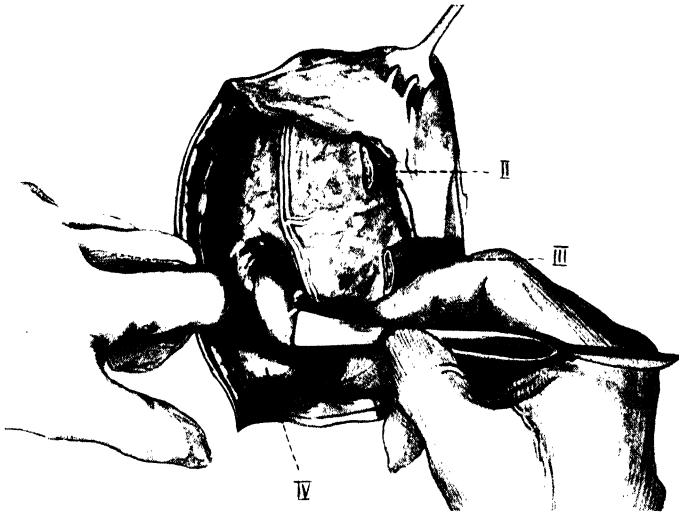
Fig. 446.—Pushing away fat with handle of scalpel, and pleura with fore-finger of left hand. The forefinger is then gently insinuated under the fourth costal cartilage. (A. W. Meyer.)

out. This opening is now enlarged by cautiously, but energetically, stretching it with the fingers (*Fig.* 447). The pleura is thus
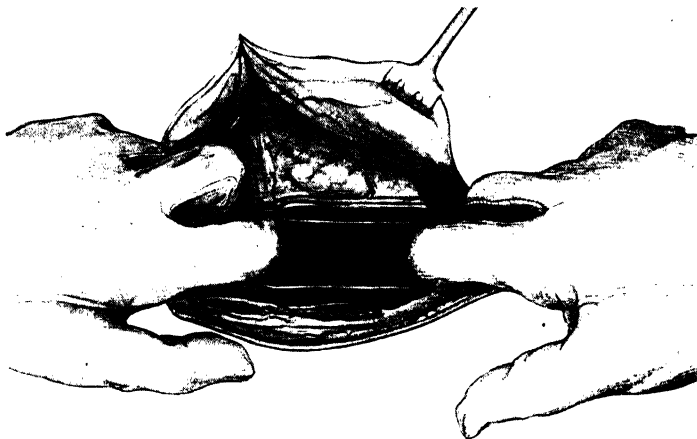
Fig. 447. The incision is slowly but forcibly widened with two forefingers.
(*A. W. Meyer.*)

still further displaced from the area of operation. The pericardial cavity is now in full view. In the cadaver one may be in doubt as to which is the aorta and which is the pulmonary artery (*Fig.* 448). In the living or rather the dying there can be no doubt : the aorta lies hidden, and the pulmonary artery, swollen and pulseless, is at once visible. The left index finger is passed into the sinus transversus pericardii, thus encircling the base of the aorta and pulmonary artery from right to left. Along this path from left to right Trendelenburg's introducer is insinuated (*Fig.* 449), and by its agency the thin rubber tube is drawn around the two vessels. This rubber tube serves a dual purpose. It will be used as a temporary tourniquet, and it is invaluable as a means of delivering

Fig. 448.—Trendelenburg's operation. Site of the incision into the pulmonary artery.

the large vessels from the depths of the pericardium to the mouth
of the wound.

Fig. 449. Modified
Trendelenburg sound intro-
duced and rubber tube
being passed around pul-
monary artery.
(*A. W. Meyer.*)

The walls of the pulmonary artery are cleared rapidly with
dissecting forceps. All is now in readiness for the crucial stage of
the operation. The free ends of
the tourniquet are crossed, and
gentle traction is applied by the
assistant, who must be ready to
obey instantly the commands
' relax ', ' more relaxed ', ' some-
what tighter ', as the case may be.

Fig. 450. The rubber tube in
action. An incision has been made
into the pulmonary artery.
(*A. W. Meyer.*)

The pulmonary artery is then
incised (*Fig.* 450). A quantity of
black blood gushes out. Greater
tension is now applied to the
rubber tube. The walls of the pul-
monary artery are as thin as those
of a vein, and these are kept apart
by the special everting forceps
(*see Fig.* 441, B). Into the right
pulmonary artery are passed
Trendelenburg's embolus forceps

E. S. 29

(*Fig.* 451), the forceps being held almost horizontal (*Fig.* 452).

Fig. 451.— Trendelenburg's thrombus forceps.

Three times the forceps are passed into the right branch in the endeavour to catch hold and withdraw emboli. The cut edges of the pulmonary artery are now grasped between the thumb and forefinger of the left hand and pressed together (*Fig.* 453). The rubber tube at this moment is

Fig. 452.— Exploring the right pulmonary artery. The forceps are almost horizontal. (*A. W. Meyer.*)
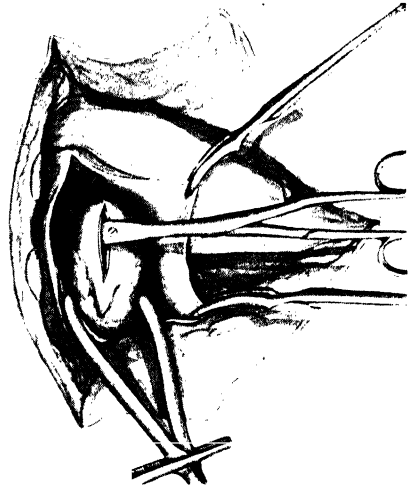
entirely relaxed. The blood is allowed to flow through the pulmonary artery for a few seconds. Then the tube for the first time is fairly energetically tightened, and with the embolus forceps
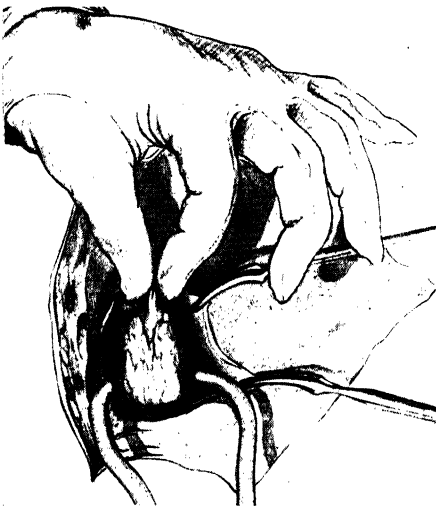
held almost vertically the left pulmonary artery is entered three times (*Fig.* 454). The heart is then relieved by renewed digital compression of the pulmonary artery, with the tube quite relaxed.

Fig. 453. — Incision in artery grasped between thumb and forefinger to close slit. (*A. W. Meyer.*)
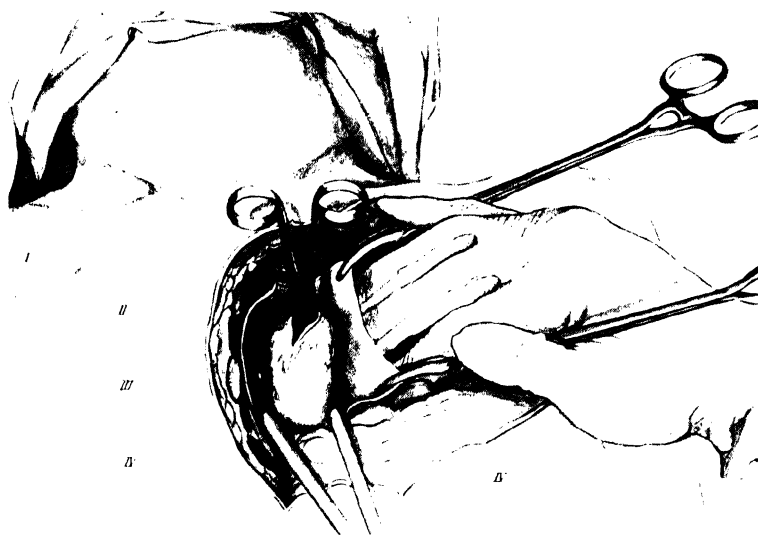
Fig. 454. Exploring the left pulmonary artery. (A. W. Meyer.)

For the second time the tube is forcefully tightened. The left hand grasps the slit vessel with dissecting forceps and the right applies the arterial clip (*Fig.* 455). The tube is completely relaxed once more while the slit in the arterial wall is being sutured. Fine interrupted sutures are employed to close this wound. The clamp is removed.

Fig. 455. Applying the arterial clip. Note that Meyer uses dissecting forceps covered with gauze; the same material is used to cover the arterial clip. (A. W. Meyer.)
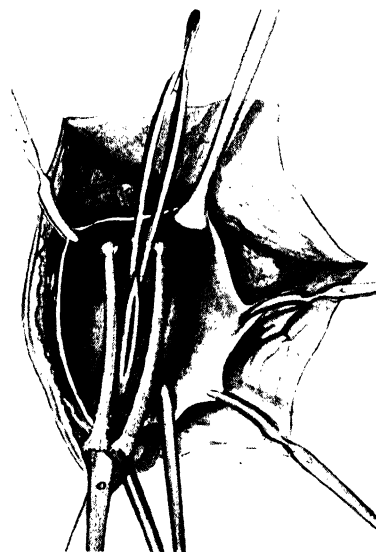
If the suture line is water-tight, the rubber tube can now be entirely removed. Massage and the injection of adrenalin may be used in the attempt to resuscitate a heart which has ceased to beat. The pericardium is then closed, the muscles are approximated, and the skin is sutured.

A. W. Meyer's First Successful Case (Figs. 456, 457).—

The patient was a woman of 54.   Six days after a gynæcological operation there were signs in the morning of severe pulmonary embolus. Trendelenburg's operation was contemplated, but it was considered to be unnecessary as yet. At 2 p.m. the physicians on duty were summoned with the cry " the sick woman is dying ". No pulse could be felt, and the patient breathed with the utmost difficulty. She was chalk-white. Operation was started within two or three minutes. A ⊢-shaped incision was made, and the second and third ribs were excised after the manner described in the text. The pleura was as thin as a spider's web and the lung could be seen moving beneath it. The pericardium was incised and Trendelenburg's sound introduced. The pulmonary artery lay still, broad, and without pulsation. The pulmonary artery was incised and the embolus forceps thrust rapidly three times into the right branch. No more emboli could be found on the third insertion. The heart then began to beat much more feebly and the breathing became more laboured. At this tragic moment the operator squeezed together the edges of the slit in the pulmonary artery and ordered that the rubber tube be released. At once there was improvement in the heart-beat. A few seconds later, as the heart action had greatly improved, slight tension was placed on the tube and a triple investigation of the left branch resulted in the removal of large emboli. A pulmonary artery

Fig. 456.—A patient of Meyer's who had emboli removed from the pulmonary artery.

clip was fixed in position. The heart began to flutter and respirations ceased. Gentle massage of the heart with the fingers induced a faint response, but respiration remained totally inhibited. At this moment, when the operator was about to order artificial respiration Dr. Djialoszynski suggested giving carbon dioxide according to Henderson's method. The patient drew a deep breath. A heart-beat followed, then another, and the heart began to beat regularly once more. The wound in the pulmonary artery was now sutured. The pulmonary artery clip was removed. Blood escaped at one point, so the clip was put back and another suture inserted. This overcame all bleeding. The pericardium, muscle, and skin were sutured. At this juncture the patient
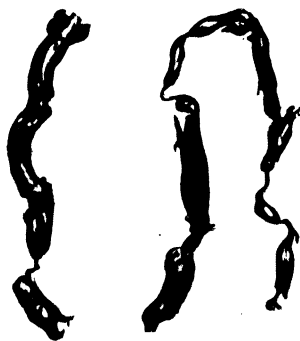
Fig. 457.—The emboli removed from patient shown in Fig. 456.

revived sufficiently to cry out in pain. Consciousness returned. After a number of anxious days she made a complete recovery.

AIR EMBOLUS

Blood transfusion, the introduction of intravenous saline, intravenous medication such as is employed in the injection of varicose veins and in the arsenical treatment of syphilis, and operations upon the neck, are all fruitful sources of occasional accidental air entry into the venous system. Those of us who were brought up in the belief that the introduction of air into a venous radicle was a regular source of sudden death must have been relieved and surprised on divers occasions to find that bubbles can enter a vein without disaster. While this knowledge is no excuse for carelessness, it may be confidently stated that, as a rule, the introduction of small quantities of air into a peripheral vein is not an occasion for alarm.

Proved sources of fatal air embolus are (1) aero-urethroscopy in the presence of a urethral hæmorrhage, and (2) the production of an artificial pneumothorax. In both these instances there is a massive introduction of air—by way of the corpus spongiosum on the one hand, and the lung (which the needle has inadvertently pierced) on the other.

At a necropsy upon a case which had died suddenly whilst aero-urethroscopy was in progress, I saw the right heart full of blood-stained

Fig. 458.—Air embolus. The aspirating needle is inserted between the fifth and sixth ribs close to the sternum, and is directed backwards and to the left for two inches. The cavity of the right ventricle is entered and its contents are aspirated.

froth. Pathological findings pave the way to correct treatment. When air embolus is suspected, the diagnosis is confirmed by immediate auscultation, and characteristic water-wheel splashing may be heard. An aspirating syringe is plunged into the right ventricle. A point is chosen, as close as possible to the sternum, between the fifth and sixth costal cartilages (*Fig.* 458).

Bingle aspirated an encapsuled ascites, and in preparation for an X-ray examination filled the resultant cavity with air. Whilst the air was being introduced subcutaneous emphysema was seen, and the patient collapsed. The pulse was imperceptible and the pupils were widely dilated. Immediate auscultation revealed the water-wheel sound. A 1-c.c. Record syringe was at hand, and the needle was plunged into the right ventricle. Three c.c. of frothy blood were aspirated. The pulse returned and consciousness was regained, though the patient died of his disease—carcinoma of the stomach —two weeks later.

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CHAPTER XXVIII

ABSCESS OF THE BREAST

UNDER the well-known principle of waiting for fluctuation, or at any rate until localization has occurred, and then obtaining free drainage by incisions radiating from the nipple, results in the majority of cases of abscess of the breast are good. The objections which can be raised to this well-tried method are mainly these : (1) The resulting scars are too often unsightly ; (2) A proportion of cases continue to discharge for weeks or months : (3) The dressings, if secondary infection is to be minimized, require the frequent attention of a skilled nurse.

THE 'CLOSED' METHOD OF TREATMENT

As heretofore, surgical judgement must be exercised as to the time at which the abscess is to be opened ; it is seldom wise to consider incising the breast until localization of the inflammation has occurred. Usually, it is best to wait for fluctuation, but occasionally, when the abscess is deep-seated, this all-important sign cannot be elicited with certainty. In order to define the limits of the abscess it is sometimes an advantage to have the affected breast emptied by a breast pump. As this is a painful process it can be deferred until the patient is under the anæsthetic.

The Operation. Everything must be absolutely in readiness before the anæsthetic is commenced. Under gas anæsthesia or evipan a single incision three-quarters of an inch in length is made at the most dependent portion of the indurated area. Where feasible, the incision is made in the 'hidden' areas of the breast namely, the areola, the submammary groove, or towards the axilla. The finger is inserted and loculi of the abscess cavity are broken down. A half-inch drainage tube is introduced into the cavity. The edges of the wound are approximated snugly around the tube by a single silk-worm-gut stitch, which passes also through the side of the tube, anchoring it into position. The tube is cut off nearly flush with the skin. Into the large tube is passed a small quarter-inch drainage tube with a number of perforations near its distal end. The small tube is then fastened to the large one by a fine silkworm-gut stitch (*Fig.* 459). A sterile gauze square, anointed liberally upon one aspect with sterile vaseline spread with a spatula, is laid upon the breast,

and the tubes are brought through a small hole cut in the centre of
the gauze. The gauze is fixed to the large tube by yet another silk-
worm-gut stitch, which also serves to close the hole snugly in the
gauze about the tube. The patient is now allowed to come out of
the anæsthetic.
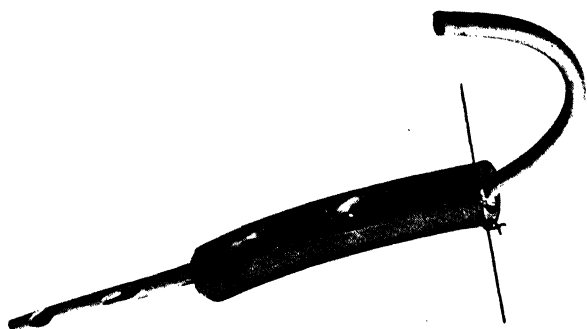
Fig. 459. — Showing arrangement of drainage tubes.

Dressings.— A liberal amount of fluffed-up gauze is arranged over
the vaseline-gauze-protected breast. This in turn is covered by a
large piece of oiled silk. Through these layers is brought the *small*
tube. The whole is supported by a many-tailed bandage, which
encircles the upper abdomen, both
breasts, and the opposite shoulder
(*Fig.* 460). The reader may be think-
ing that this is complicated and
unnecessary, but the whole procedure
is carried out in a very few minutes
if the simple requisites are got ready
beforehand. The boon of this method
becomes apparent in the supreme
simplicity of the after-treatment.

After-treatment. The patient lies
in bed in a comfortable semi-recum-
bent position. Every four hours the
measured quantity of Dakin's solution
is injected down the tube (*Fig.* 461).
The overflow is absorbed automatically
into the fluffed gauze. If necessary,
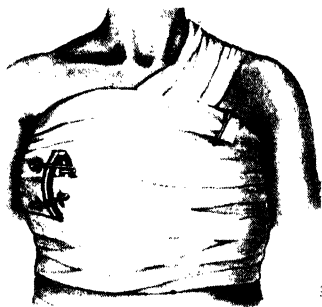
Fig. 460.— Method of applying
the overall many-tailed bandage, and
of fixing the end of the irrigating tube
when not in use. In practice the free
end of the tube is wrapped up in a
piece of gauze moist with Dakin's
solution.

this instillation can be done by an unskilled nurse, or even by the
patient herself. The dressing is not disturbed for twenty-four hours.

At the end of that time the many-tailed bandage is loosened and the fluffed gauze is changed. Providing the temperature chart is satisfactory, and the patient does not complain of discomfort (in my experience she has always been extremely comfortable), the inner dressing of vaseline gauze and the tubes are not touched. This labour-saving,

Dakin's Solution

Many-tailed bandage

Oiled silk

Fluffed gauze

Vaselined gauze
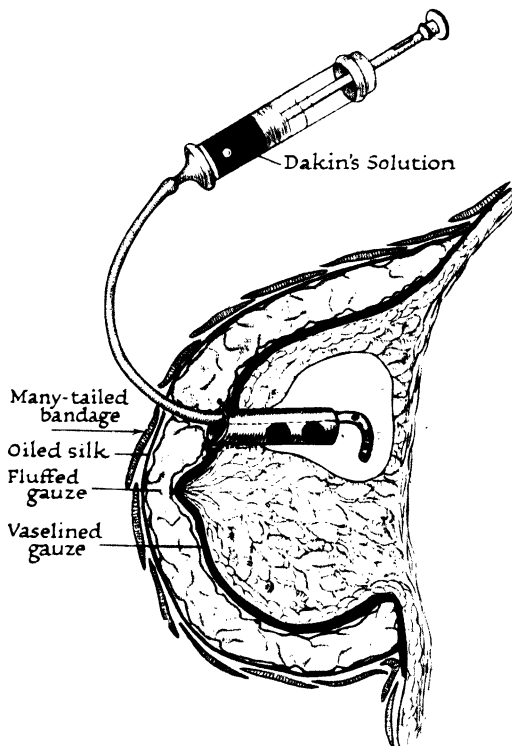
Fig. 461. –Diagram depicting the technique described in the text. The amount of Dakin's solution to fill the abscess cavity has been ascertained at the time of the operation. This quantity is injected down the small tube every four hours. The overflow runs out of the large tube and is absorbed by the gauze. The layer of vaselined gauze protects the skin from the irritating effect of the fluid.

pain-sparing régime is followed until the fourth or fifth day, when the surgeon himself removes all the dressings and usually takes out the tubes.

More Remote After-treatment. A fresh piece of vaseline gauze, which is so essential in preventing cutaneous erosion by the Dakin's solution, is applied. By means of a rubber catheter the abscess

cavity is washed out with the solution twice a day. It will not be long before irrigation need be undertaken but once a day. By approximately the tenth day the wound presents a healthy, granulating appearance, but there appears from time to time some sero-purulent discharge, probably admixed with a little leakage of secreted milk. The latter is washed away with Dakin's solution diluted with saline to half or quarter strength. The time has now arrived for the vaseline gauze square to be discarded. It is usually advisable to keep a wisp of vaseline-impregnated gauze in the mouth of the wound for a day or two.

Convalescence.— The only dressing now required is a piece of dry folded gauze over the wound, kept in place by adhesive plaster. The patient can get up, wearing an ordinary brassière for support. There is always a considerable indurated area in the breast at this period, and it persists for some time. Iodine-in-milk therapy, similar to that described for the treatment of actinomycosis, has been followed by a more rapid absorption of the induration and an obvious improvement in the patient's general condition.

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CHAPTER XXIX

THE SPINE

MENINGOCELE

I was asked to see a newborn male child with a meningocele the size of a Jaffa orange at the occipito-cervical junction. The walls of the sac were so thin that fluid could be seen within. It was obvious that rupture of the cyst was imminent. Operation was undertaken, the babe being fifteen hours old. Anæsthesia was induced with a few drops of chloroform. An elliptical incision was made above and below the neck of the sac. By dissection it could be shown that the neck of the sac was as narrow as a pencil and was transparent. This stalk was ligatured with strong catgut, then the cyst was cut away with one snip of the scissors, and the skin was closed. The child thrived.

Spinal meningocele may be a condition necessitating urgent operation. If the walls of the sac are delicate and transparent, a slight injury, even the rubbing of the bedclothes, will rupture it. When the sac bursts fatal meningitis surely follows (*Fig.* 462).

Fig. 462. ...which burst. The child died of meningitis forty-eight hours later.

Whether the meningocele is in the cervical region or, as is more usual, in the lumbar (*Figs.* 462, 463), the principle of the operation is the same. An elliptical transverse incision encircles the swelling close to the base of the sac. The operation proceeds in a manner comparable to that for umbilical hernia. When the neck has been reached it may be found to be distinctly pedunculated, the signal that we may have no fear in applying a ligature.

Should the neck incline towards the sessile type, it is probable
that nerve-roots lie on its under surface; it is, in fact, a meningo-
myelocele. There is usually no difficulty in recognizing nerve-roots
before the sac is opened, for they can be seen through the semi-
transparent membrane. The sac is opened and snipped away, deftly
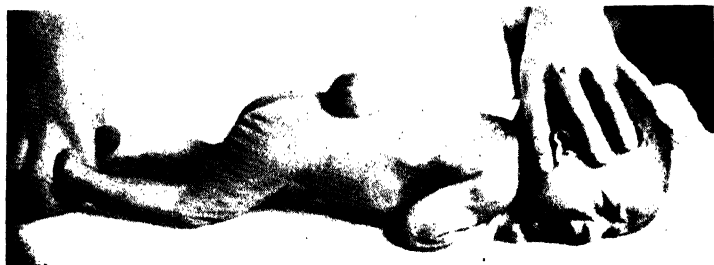
Fig. 463. —Meningomyelocele of the sessile type. It was remove

avoiding nerves. Quickly the dural edges are stitched together.
Speed is necessary to avoid undue escape of the cerebrospinal fluid.
If the babe's general condition permits, a simple plastic operation
may be performed. The sheath of the erector spinæ on each side is
incised and the two medial cut edges are brought together (*Fig.* 464).
The skin is now united. By undercutting it is usually possible to
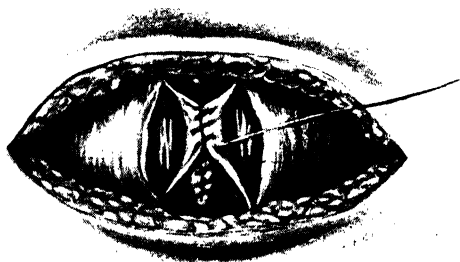
Fig. 464. —Operation for meningocele. Suturing the cut edges of the sheath
of the erector spinæ.

bridge across the gap. Occasionally it may be necessary to relieve
tension by making a transverse cut some distance from the wound.

INJURIES OF THE SPINE

A man has fallen and is believed to have broken his back. If
the body of a vertebra is fractured (*Fig.* 465), it is of paramount

importance to avoid flexion of the spine, for flexion increases the angular deformity and may cause untold damage to the cord. Therefore first-aid workers should be taught that a patient with an injury to the spine must be carried *face downwards.*

On hearing that there is a case of spinal injury on the way, the nursing sister will have prepared a bed with fracture-boards beneath the mattress and a water-bed on top of it. The stretcher is carried to the foot of the bed and six assistants are summoned. The first pair grasp the patient's shoulders, two more insinuate their arms beneath the pelvis, while the remaining two take each one thigh.
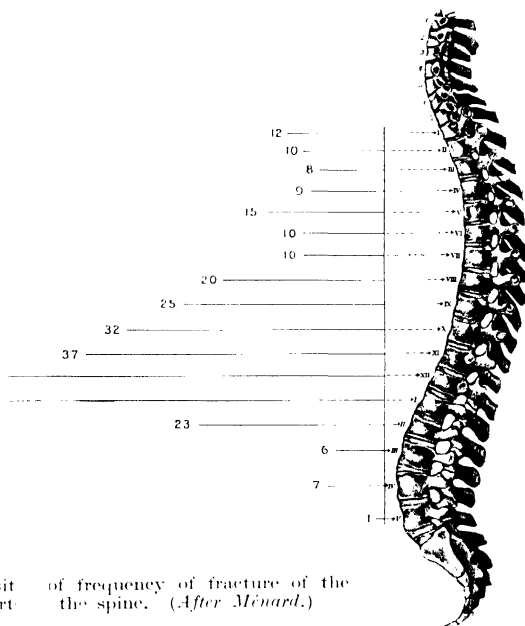
Fig. 465. The relative sit of frequency of fracture of the dorsal and lumbar part the spine. (*After Ménard.*)

If the injury is in the cervical region, a seventh—the surgeon himself—takes charge of the head. At the given command the bearers gently raise their burden, move together from the foot towards the head of the bed, upon which they lower the patient face downwards. The head is turned and laid on a small soft pillow. The clothing is cut off. Clinical examination is deferred until shock has been treated.

THE SPINAL CORD IS NOT SERIOUSLY INVOLVED

Application of a Plaster Jacket.—If the physical signs and subsequent X-ray film show that there is a crush fracture of the body of the vertebra, we cannot do better than apply a plaster jacket with the spinal column in a hyperextended position. Watson Jones gives

admirable instructions for the application of this jacket. A general
anæsthetic is unnecessary, and the position required can be main-
tained more easily by the conscious patient. One-quarter or one-
third of a grain of morphia is given half an hour before. Two tables
are arranged end-to-end, with a space between slightly greater than
the length of the patient's trunk. The front table is raised on blocks
or chairs so that it is about two feet higher than the other ; although
not essential, it is an advantage to use an operating table of adjust-
able height, so that the hyperextension can be attained gradually
by screwing up the table after the patient is in position. Throughout
treatment, flexion of the spine must be avoided. The patient is
therefore lifted *face downwards* on to the lower table, and a double

Fig. 466 -Hyperextension of the spine secured and maintained by two
tables of different height. (*E. T. Cato — by kind permission of the ' Australian and
New Zealand Journal of Surgery'.*)

layer of stockinette is pulled over the trunk and stitched over the
shoulders and beneath the perineum. The spinous processes and the
iliac crests may be further protected by small pads of adhesive felt
or sorbo sponge, but it is essential that the plaster should fit very
closely ; bulky padding with wool or felt is to be avoided. A closely
fitting woollen bathing costume is an excellent substitute.

The patient is now assisted into such a position that he is grip-
ping the edge of the higher table with his abducted arms, the head
resting on a small pillow. The lower table supports his lower limbs
as high as the upper thigh, but between the groins and the neck there
is no support. In this position he is unable to prevent his spine
from gently sagging into full hyperextension (*Fig.* 466). The plaster

is applied at once, and is moulded to the curve of the spine, sacrum, and iliac crests. The rubbing in of layer after layer of plaster gives sufficient pressure to ensure that the normal limit of hyperextension has been reached; beyond this no manipulation of any sort should be employed. The plaster should extend up to the neck, and although it may be cut out below each axilla to allow free use of the arms, none must be removed from the front of the thorax (*Fig.* 467). It extends over the sacrum and down to the level of the trochanters and symphysis pubis, with a small area cut out over each groin to allow flexion of the hip.

After-treatment.— As soon as the plaster is dry the patient is encouraged to move about in bed, and is turned frequently to avoid pulmonary congestion. From the second or third day in uncomplicated cases he should lift his head from the bed against resistance and

Fig. 467. -Plaster jacket completed. (After R. Watson Jones.)

each limb should be lifted with the knee straight. These exercises prevent wasting of the spinal muscles, and should be practised at regular intervals. After ten days the patient may get up, and soon afterwards he is encouraged to walk. Protection of the vertebra is necessary for four months. If the exercises are constantly practised, the plaster may be retained throughout this period.

SIGNS OF A SEVERE INJURY TO THE SPINAL CORD ARE PRESENT

Soon after any severe spinal injury, whether the spinal cord is actually damaged or not, the patient suffers from spinal *shock*, and the shock requires treatment on general lines. The immediate shock is followed by a *stage of flaccid paralysis*. This paralysis does not signify that there is a complete lesion of the cord. Indeed, it does not necessarily imply that the cord has been macroscopically damaged at all. To quote a classical case from *Guy's Hospital Reports*:—

> A woman of 59 years of age fell on her back and immediately developed paralysis of the upper and lower extremities. On the tenth day she died of pneumonia. A careful post-mortem examination was made, and no anatomical changes were found either in the brain or in the cord. There were no evidences of effusion of blood in the spinal cord or canal.

The stage of flaccid paralysis may last from one to three weeks. During this time it is impossible to make a differential diagnosis between a complete and an incomplete lesion. This period is followed by the *stage of reflex action*, and it is during this stage, as Riddoch has shown from examination of a large number of spinal injuries

during the great War, that by careful clinical examination it is possible to collect data upon which to settle the all-important question whether the lesion is complete or incomplete.

Under no circumstances is laminectomy justifiable during the stage of shock. Because it is impossible to make a differential diagnosis, and because, also, only harm can result by operating if the lesion is complete, laminectomy is again usually contra-indicated during the stage of flaccid paralysis. We shall discuss the indications for laminectomy later. For the present there are more urgent matters to occupy our attention.

Position of the Patient.—Once it is settled that there is an injury to the spinal *cord* the prone position is impracticable. The problem of posture is easily solved if the turntable bed invented by Professor Hey Groves, and made by Nesbit, is available. In other circumstances an emergency splint may be useful.

Emergency Splint.—If the patient must be moved, as may be the case for a satisfactory X-ray, or on those rare occasions when he must be conveyed to the operating theatre, some form of splint is essential. A long, well-padded board is effective. This is carefully pushed under the patient's back, and maintained in position with an abdominal binder. If the fracture is in the cervical region, the splint must extend beyond the head and the head be supported by a sand-bag.

Radiography.—X-ray photographs are taken as soon as arrangements can be made. A lateral view is often particularly instructive.

Treatment of Retention of Urine.—Ascending pyelonephritis is a common and very lethal complication. In the first instance the patient must be catheterized with full aseptic precautions. Urinary antiseptics are prescribed in order to minimize infection. Repeated catheterization may be necessary, but, as this must eventually lead to infection, other means of emptying the bladder should be devised. Murphy states that the bladder will automatically empty if the prostate is massaged. This suggestion is worth a trial. When the stage of reflex action has been reached, it is well known that even a slight nocuous stimulus, such as pinching the thigh, will initiate micturition. Suprapubic drainage of the bladder is the method I favour strongly in these cases (*see* pp. 359, 376).

Prevention of Bed-sores.—The patient must be placed upon an air- or water-bed, the sheets are to be kept free from wrinkles or bread crumbs, and hot-water bottles should not be used. Attention to the skin is of great importance. After the bowels have acted is a good time to treat the back with borax in spirit or a 1 per cent solution of formaldehyde ; both these solutions tend to toughen the

skin and are antiseptic. The buttocks, heels, malleoli, and lower parts of the back are watched by the nurse for redness, at the first sign of which a ring of cotton-wool or a ring air-cushion is placed about the area to prevent further pressure. An excellent method of preventing bed-sores is to cover all pressure points with elastoplast, and this is now our routine.

Prevention of Drop-foot.—Drop-foot can be largely prevented by having the feet kept at right angles with sand-bags.

Relief of Persistent Priapism.—*See* p. 407.

Lumbar Puncture.—There should be no hesitation in performing lumbar puncture if the symptoms point to hæmatomyelia or hæmatorachis. The needle used should be comparatively large. Evacuation of blood from the spinal canal is often followed by rapid improvement as regards paralysis. Lumbar puncture is valuable in diagnosis and as a therapeutic measure in spinal injuries.

Fig. 468.--Method of reducing a dislocation of a dorsal vertebra.

Treatment of an Obvious Dislocation.—This is usually a fracture-dislocation, but it is essential to endeavour to reduce it. The prognosis of spinal injuries is always serious, and fatalities are especially numerous in fracture-dislocations of the cervical vertebræ. As soon as the shock has been treated the patient is conveyed to the theatre, the splint already referred to being in position. Still on the splint, he is anæsthetized. A careful attempt is now made to reduce the

dislocation. The operator grasps the patient's head or shoulders while the assistant makes steady traction on the lower extremities, the patient being in the prone position (*Fig.* 468). If the dislocation is reduced, the patient is again strapped to the splint. As soon as he is back in bed a Sayre's collar may be applied. An instrument-maker is consulted and a jacket is made, or in suitable cases a plaster jacket is applied (*Fig.* 469).

When the lesion is high in the cervical region, traction on the head with counter-traction on the shoulders should be employed.

Sir William Thorburn's Case.—

A labourer fell head first down a flight of steps. He was unable to pick himself up, and when brought to hospital showed signs of a grave lesion of the spinal cord. His left upper limb was completely paralysed and anæsthetic. The head and neck were bent to the right, and a deformity could be felt in the cervical spines. Having concluded that there was a dislocation, probably unilateral, the shoulders were firmly grasped and steadied while traction was made on the head. The head was drawn upwards and to the right, and then towards the left. A slight snap was felt and the head became more nearly, but not quite, straight. The same procedure was repeated and another snap was felt, whereupon the head came into its normal position. Improvement in the symptoms was almost immediate, although retention of urine had to be relieved for some time. A certain degree of spasticity of gait and numbness of the legs persisted, but the patient was able to return to light work.

Fig. 469.— Fracture-dislocation of the 3 vical vertebra reduced by the method descr the text, followed by the immediate appl of this plaster cast. Paralysis diminished n the 2nd day. The patient made a good recov

If the dislocation cannot be reduced, immediate operation is advised by some. On the other hand, operative mortality is so high when the lesion is in the cervical region—the usual situation—that the modern tendency is to return the patient to bed and await developments. With the latter policy we must agree, for ineffectual attempts at reduction are bound to have subtracted from the already meagre hold the patient has on life.

Indications for Laminectomy.—Accumulated evidence makes it abundantly clear that as a general rule immediate operation in spinal injuries is to be avoided. But, conservative as our attitude is towards

these injuries, there are occasions where more active measures are imperative.

Immediate Laminectomy. The only condition in which immediate laminectomy is to be considered is *when there is an open wound*, particularly if a foreign body such as a bullet lies within the spinal canal.

Early Laminectomy. This will be indicated *when the X-ray shows that the arch of the vertebra has been fractured and is indisputably projecting into the spinal canal.* Under such conditions operation should be undertaken within two days, or as soon as the general condition of the patient permits.

Laminectomy at a Later Stage. Here the operation is undertaken *when the stage of reflex action has been reached*, and thus diagnosis is possible. It has already been stated that this stage takes one to three weeks to show itself. Laminectomy will be advised *when the lesion has been shown to be incomplete but there is no tendency to improvement.*

LAMINECTOMY

The patient lies prone upon the table with a sand-bag under the epigastrium. If the exposure is to be made in the lumbar region, the sand-bag is arranged so as to obliterate the lumbar curve as much as possible. For the cervical region the head must be supported on a head-rest such as is used for the operation of suboccipital decompression. Laminectomy in the cervical region is not a difficult operation, and the same may be said of the dorsal region, but when it comes to the lumbar vertebræ difficulties increase, owing to the depth of these bones and the comparative smallness of their laminæ. It is fortunate that in the most dangerous (upper) regions of the spine the cord can be exposed comparatively quickly.

Make a longitudinal median incision 8 in. long (*Fig.* 470) with its centre over the vertebra which is damaged. Reflect the skin on either side and fix towels to the skin edges. Deepen the incision until the spinous processes are reached. A bold cut is now made through the

Fig. 470.—An incision for laminectomy.

muscles just to one side of the spinous processes. This is carried right down to the laminæ. Considerable hæmorrhage occurs, and this

is arrested by plugging the space firmly with gauze. After a few moments the gauze is removed, and using a broad chisel after the manner of a periosteal elevator, the muscular mass is elevated from the laminæ. This cavity is again plugged with gauze whilst a similar procedure is carried out on the opposite side. By utilizing the method of gauze pressure on each side, the number of bleeding points which require ligaturing are few. As soon as hæmostasis is satisfactory the muscular masses are strongly retracted, revealing the spinous processes. Five spinous processes should be
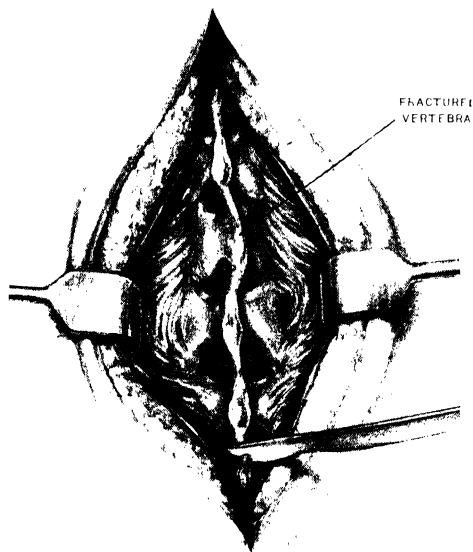
Fig. 471.—Laminectomy. The fractured vertebra and two vertebræ above and two below have been exposed. The interspinous ligament between V5 and V6 is being divided.

displayed, two above and two below the injured vertebra. For convenience these vertebræ will be referred to as V1, V2, V3, V4, and V5, V3 being the injured vertebra. Divide the lowest interspinous ligament (*Fig.* 471). With bone-cutting forceps remove cleanly the lower two spinous processes as close to their base as possible. With the knife divide the interspinous ligament between V3 and V4, thus removing in one piece the two lowermost spinous processes. Pass to the upper end of the wound and remove the spinous processes of V1 and V2 in the same manner. We are ready for the crucial stage of the operation—exposing the dura.

The safest method is to use a trephine, and, following an established dictum, always trephine sound bone. Apply a $\frac{3}{4}$-in. trephine to the lamina of V5 (*Fig.* 472). Having removed the disc of bone,
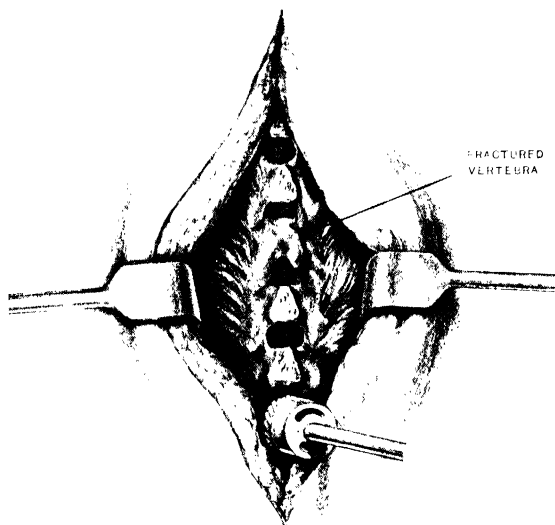
laminæ. (*After Sir James Walton.*)

enlarge the opening with nibbling forceps (*Fig.* 473), first carefully separating the dura from the bone with some flat instrument such as a Horsley's seeker. Employing the seeker, then nibbling, is a safe but slow method of exposing the dura. A quicker method, if suitable

Fig. 473. Laminectomy. The broken lines indicate the amount of bone to be removed in order to expose the spinal cord adequately. *a,* Cervical; *b,* Dorsal; *c,* Lumbar.

instruments are at hand, is to use a narrow-bladed bone-cutting forceps, one blade of which is inserted between the under surface of the lamina and the dura. If the latter method is to be used, it is essential to be certain that the dura has been separated from the lamina, and when the blade has been introduced there should be very little pressure on the cord. In this way the lamina is divided on either side as near as possible to the articular processes. By one or other method the laminæ of V4 and V5 have now been removed. The spinous process of V3, the fractured vertebra, is then grasped and gently pulled. It may be found that it is loose and can be removed.

Fig. 474.—Exerting traction upon a divided dentate ligament in rotate the cord.

If not, its laminæ are divided, as also are those of the remaining V2 and V1. The dura is now exposed, but there is an overhanging ledge of bone on either side. This may be removed by nibbling forceps or Hudson's guillotine forceps, which have been specially designed for this work and are ideal for the purpose. The dura is then in full view.

Except in the case of an extradural abscess the dura should be opened well away from the site of the lesion. Transfix a point of the dura with a stitch and by its agency elevate this membrane and incise it. The opening is enlarged with scissors. The appearance of

the crushed or contused cord varies. Sometimes as soon as the dural
sac is opened, a transverse discoloured depression is noted. At
others, the cord in the vicinity of the fracture is œdematous. If the
cord is swollen and œdematous Elsberg recommends that a tiny
incision be made into the posterior median septum.

No attempt should be made to remove broken-down cord tissue.
To suture a divided or partially divided cord is worse than useless,
for regeneration is impossible. On the other hand, the component
parts of the cauda equina do regenerate, and suture after the manner
of a nerve should be undertaken whenever possible.
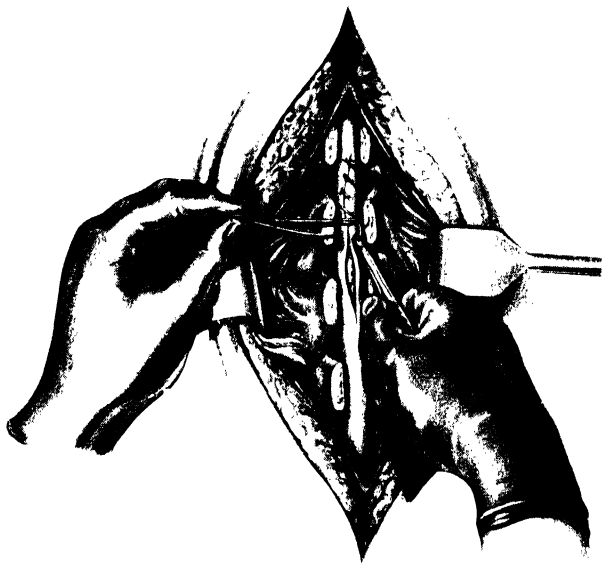
Fig. 475. Laminectomy. Closure of the

If it is necessary to rotate the cord so as to get to the anterior
surface, such as may be necessary for the removal of a foreign body,
a dentate ligament may be picked up with forceps, and with fine
scissors its attachment to the dura is severed. By exerting traction
on this slip the cord can be delicately rotated (*Fig.* 474) with the
least possible disturbance.

Reconstruction.—Except in the presence of sepsis the dura is
closed completely by a fine running suture (*Fig.* 475). The muscles
are then brought together by strong interrupted catgut stitches.
Lastly the fascia is united and the skin closed.

LUMBAR PUNCTURE NEEDLE BROKEN IN THE SPINE

L. H. Landry's Case.—

The patient was a man of 34. The needle had broken off during lumbar puncture the day previously. The patient was complaining of severe pain radiating down the thighs. An incision was made over the third, fourth, and fifth lumbar vertebræ and the laminæ were exposed as for laminectomy. It was not until the spinous processes had been removed that the needle was found between the third and fourth vertebræ. Its removal was followed by a flow of cerebrospinal fluid.

ACUTE EPIDURAL SPINAL ABSCESS

If only an early diagnosis can be made, this is a remediable condition. Only too often acute epidural spinal abscess is not recognized until it is either too late to drain the abscess or not early enough to permit a complete recovery of the paralysis. I have only met with one example.

A man of 20, who had been suffering from a boil of the forearm, was walking home when he felt his legs give way beneath him. He was carried home, and that night developed retention of urine. During the ten days which followed, the paralysis steadily increased and the temperature suggested a deep-seated infective lesion. When I saw him the temperature was 103° and there was complete sensory and motor palsy from the level of the tenth dorsal vertebra. The bladder was full and he had had to be catheterized during the past week. Lumbar puncture resulted in a feeble flow of yellow cerebrospinal fluid, which soon ceased. With the help of a medical colleague the lesion was localized at the level of the tenth dorsal vertebra.

Operation.—The first step was the introduction of a de Pezzer catheter into the bladder suprapubically. Laminectomy was performed. One lamina only was removed and there was a gush of pus, about a pint being evacuated. The patient improved up to a point, until three weeks later he developed an empyema. He lived for a further two months.

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CHAPTER XXX

THE HEAD

THE SCALP

Avulsion of the Scalp.—Owing to better protection of machinery, compulsory wearing of caps by factory girls, and modern fashions in hairdressing, avulsion of the scalp, common enough in days gone by, is now infrequent.

As regards treatment, if there is no actual loss of substance the edges of the scalp are trimmed and the scalp is sutured accurately into position. Thanks to the excellent blood-supply, union often occurs providing the avulsed area is attached by a reasonably broad base.

Mrs. A. W., aged 80, was brought to hospital with the entire scalp hanging over the nape of the neck. The pedicle which attached the scalp to the body was barely three inches wide. After trimming, and sterilizing the interior with tincture of iodine, the parts were sutured into position. Union occurred by first intention.

Wound of the Scalp with Loss of Substance.— The tripod incision may prove useful. The plastic principle involved is understandable by referring to *Fig.* 476. For loss of larger areas amounting to partial avulsion of the scalp Mitchell's method should be employed. There

Fig. 476.—Cushing's tripod incision for a wound of the scalp with less of substanc

is no object in performing this operation urgently ; indeed, it is best to postpone it for several days, during which time the skin and the pericranium are rendered as aseptic as possible. *Figs.* 477 A and B illustrate the principle. A series of incisions (*Fig.* 477 A) permit mobilization of strips of the whole thickness of the scalp provided with adequate blood-supply. These are levered into the desired position and are kept in place by tension sutures (*Fig.* 477 B). The
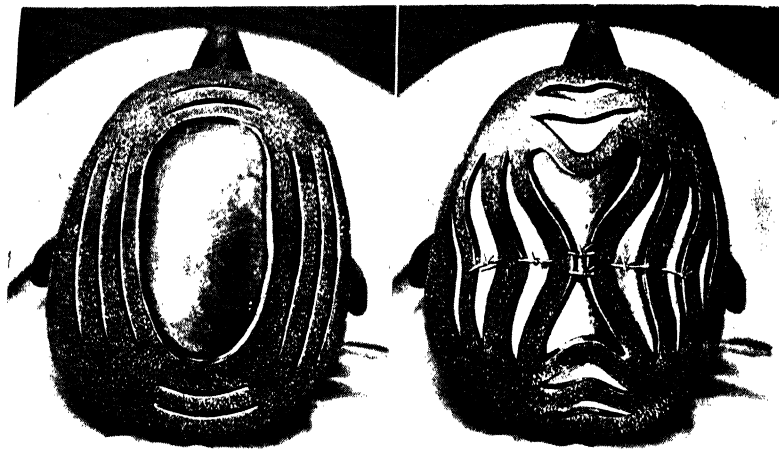
Fig. 477.— Mitchell's method of covering a large defect of the scalp.

intervening bare areas soon granulate. The advantage of this method is that a bare area is covered with a considerable amount of hair-bearing skin.

'**Cut Head.**'—Scalp wounds should be treated by excision of the edges of the wound before suture. It goes without saying that a wide area of the hairy scalp should be shaved around the wound. Curved scissors are better than a scalpel for excising and trimming wound edges. The interior may be examined with a sterile probe for a fracture, but in the absence of some signs pointing to remediable mischief within the skull fissured fractures should be left alone. Many times I have been called to see a case where the house surgeon has found, or thought that he has found, a fissured fracture. The picture of a fissured fracture of the outer table with extensive comminution of the inner is riveted in the mind of the student, largely because of the attractive picture copied from book to book. In reality I believe this to be of the greatest rarity in civil practice. Should there be some hidden lesion, physical signs will indicate that

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the skull must be opened. In the absence of these signs all that is necessary in the first instance is that the wound should be swabbed with iodine, the skin edges trimmed, and the wound closed. The patient is then watched, as should be the routine in all cases of concussion, to which we now direct our attention. The only variation in the routine procedure is that the help of a radiograph will be sought at the earliest possible opportunity, whereas in the case of simple concussion the radiograph is taken at any time before the patient leaves hospital.

CONCUSSION

Following the Hippocratic aphorism " No head injury is so slight that it should be neglected ", every patient who is concussed even slightly should be confined to bed for at least fourteen days.

A patient is brought in in a state of concussion. The routine may be summarized as follows. Notes are made, and physical signs recorded. Providing there are no other injuries or conditions requiring immediate attention, instructions are given : (1) To remove the pillow and allow the patient to lie quite flat in bed ; (2) To keep the patient as quiet as possible ; (3) To record the pulse and temperature every two hours ; (4) To report immediately any change in the patient's condition, particularly any lowering of the pulse-rate.

In the majority of instances recovery of the patient is without incident. A radiograph of the skull should always be taken, largely as a protective measure for the surgeon in the event of litigation. In the main, it may be said that the less we do in cases of head injury the better. Emphatically the attitude of the surgeon should be one of masterly inactivity. He should organize a system which ensures that the patient is watched carefully. For noisy, troublesome patients a male attendant is essential. A nurse's duty is not to struggle with unruly patients, but to record the pulse, temperature, and respirations, and, if she is skilled enough, blood-pressure as well.

During a time of stress, understaffing, and change of nurses, the standing rules were not observed in one particular case. A young man was admitted at 6 p.m. with simple concussion. I was called to see him in the early hours of the following morning. He had just died from middle meningeal hæmorrhage. In order to avoid the repetition of an eminently remediable case slipping through our fingers instructions must be given to the nurse to prepare an hourly or two-hourly pulse chart through the night ; to report at once : (*a*) Fits ; (*b*) Alterations in the size of the pupils, particularly in equality ; and, above all, (*c*) Slowing of the pulse-rate. A large experience of head injuries has shown me that, after scalp wounds have received proper attention, more than 90 per cent of cases

admitted as concussion require no treatment other than rest in bed. We will now turn to the minority, which must engage the surgeon's active attention.

INCREASED INTRACRANIAL TENSION

Apart from the all-important intracranial hæmorrhages which will be dealt with later, there are cases of increased intracranial tension which require our close consideration. The commonest class consists of those cases in which a severe reaction follows awakening from the concussed state ; here severe persistent headache is a leading symptom.

The Reduction of Increased Intracranial Tension.—

1. *Magnesium Sulphate by Mouth.*—This is the simplest method when the patient is able and willing to swallow the drug. Its action is slow, but certain and safe.

A saturated solution of magnesium sulphate is prepared. The patient is given half an ounce every two hours for twenty-four to forty-eight hours ; half an ounce every three hours for the next forty-eight hours. The dose is gradually reduced until the seventh or tenth day, when it is discontinued. In order to avoid excessive purgation no plain water is allowed while the patient is taking this treatment. The fluids allowed are broth, lemonade, and barley water in restricted quantities. It is curious that purgation does not result when the intake of water is reasonably restricted.

2. *Magnesium Sulphate per Rectum.*— If skilfully administered this is the best method for general use. Three ounces of crystals are dissolved in six ounces of warm water. By means of a catheter the resulting solution is run slowly into the rectum. It must gravitate slowly in order to avoid acting as an enema. The injection should be repeated every four hours until the symptoms have abated. No toxic effects have been observed in a large number of administrations of magnesium sulphate by many observers.

3. *Lumbar Puncture.*—The puncture is made between the 3rd and 4th lumbar vertebræ with a fine needle, and from 5 to 10 c.c. of fluid are evacuated slowly. The puncture may be repeated, if necessary, in twelve or twenty-four hours. Providing the fluid is evacuated slowly there is no danger. The possibility of the crowding of the medulla into the foramen magnum –the danger in cases of cerebral tumour— does not obtain in acute traumatic cases. Instruments are on the market whereby the cerebrospinal fluid pressure can be measured by a mercurial manometer attached to the spinal needle. The amount of cerebrospinal fluid to be withdrawn can then be measured with scientific accuracy.

4. *Venesection.*—This is also an effective method of lowering intracranial tension. I have not made much use of it myself.

5. *Intravenous Hypertonic Saline* is a drastic method not without danger. It is only to be recommended in desperate cases. For instance, we have decided to operate for intracranial hæmorrhage. The patient is compressed so deeply that it is impossible to tell which is the side of the lesion. Just before the operation hypertonic saline is given with the dual object of temporarily lifting the veil which obscures the signs and rendering decompression by craniotomy less abrupt. The introduction of hypertonic saline into the circulation dehydrates an œdematous brain and thus rapidly decreases intracranial tension. Before using this method take a reading of the blood-pressure. It is hopeless to decompress by any method if the blood-pressure is below normal (Malone).

Hypertonic solutions in contact with subcutaneous tissues cause necrosis. Therefore, when hypertonic saline has to be given, a little normal saline should be run into the vein first to see that the needle is within the lumen ; 20 c.c. of a 30 per cent solution of saline are then run into the vein. H. Cohen, of Liverpool, described a series of cases of advanced compression from cerebral tumour treated by this method. He found that within five to ten minutes of the injection, after a curious feeling which the patient described as " burning ", the intense headache disappeared, and there was a period of freedom for ten hours to two days.

6. *Craniotomy* (see p. 479).

The reduction of increased intracranial tension by one of the above methods, particularly Method 2, is a valuable form of therapeusis. These measures should never be employed as a routine in cases of head injury, but only when there is a definite indication for their use. The only time that dehydration is of great service is during secondary œdema, which never occurs before the second or third day (Jefferson).

The peculiar danger of decreasing intracranial pressure is increasing intracranial hæmorrhage ; therefore it should never be employed unless this diagnosis has been ruled out or we are prepared to follow immediately by craniotomy. " If by any chance a patient has an extradural or a subdural hæmorrhage a lumbar puncture is the very worst thing that can be done " (Dandy).

ON SHAVING THE SCALP

All cases of early acute cerebral compression should have the scalp shaved. This allows a thorough examination of the vertex ; more than once I have seen a tell-tale hæmatoma revealed which had been obscured by hair. Should the compression increase and operation become necessary, much time is saved by having the head in a state of preparation for surgical intervention.

CEREBRAL IRRITATION

The patient should be placed in a darkened room with a special attendant to look after him. If magnesium sulphate can be given per rectum and retained, so much the better. Half an ounce of paraldehyde can be added to the first dose and may ensure some much needed rest. If the rectal injection is not tolerated, magnesium sulphate may be added to the feeds, for the patient will usually take fluid from a feeding cup. If symptoms of cerebral irritation persist for forty-eight hours, subtemporal decompression should be considered. Wilfred Trotter emphasizes that a decompression operation should be more often resorted to in cerebral irritation, for it allows subsidence of the cerebral œdema which causes the symptoms. Persistent delirium in particular should always cause the question of operation to be raised.

EXTRADURAL HÆMATOMA : MIDDLE MENINGEAL HÆMORRHAGE

Hæmorrhage may arise from the anterior branch, the posterior branch, or the main trunk. When middle meningeal hæmorrhage is diagnosed the skull is opened over the anterior branch, because
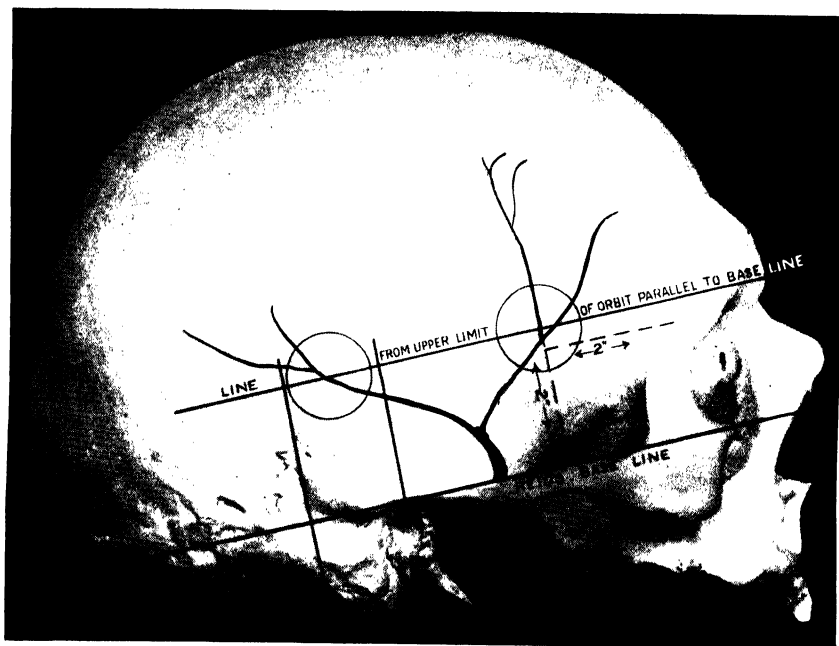
Fig. 478. —The surface markings of the middle meningeal artery, with the points most advantageous for trephining.

observers have shown that it is the anterior branch which is usually torn. Take a bradawl or other sharp-pointed instrument, and drive it through the scalp 2 in. behind the external angular process and 2 in. above the zygoma (*Fig.* 479 A); impart sufficient propulsion to the instrument for its point to impinge upon and mark the outer table of the skull. When the skull has been exposed, the mark can be found and the pin of the trephine applied to it.

The anatomical instructions for marking out the posterior branch are complex. The reader's memory may be refreshed by referring to *Fig.* 478. It is sufficiently accurate to drive the bradawl half an inch above and behind Darwin's tubercle of the pinna (or where Darwin's tubercle should be) with the pinna lying flat against the
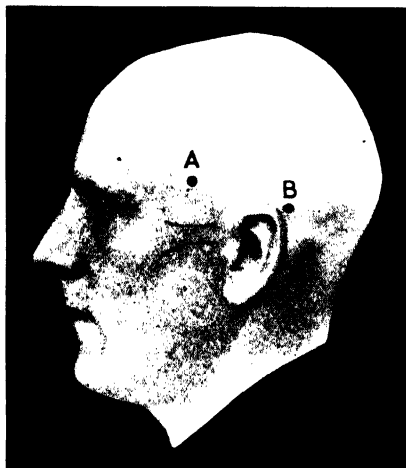
Fig. 479. Bradawl markings impinging on the outer table of the skull so that points to apply the trephine [(A) for anterior branch (B) for posterior branch] can be recognized easily when the scalp has been reflected suitably.

side of the head (*Fig.* 479 B). It is desirable to mark the skull with the bradawl over both the anterior and the posterior branches before commencing operation. The relative positions of the flaps for the exposure of the anterior and posterior branches of the middle meningeal artery are shown in *Fig.* 480.

Craniotomy. If the skull is opened, blood-clot turned out, and the source of the haemorrhage controlled, the prognosis is excellent, providing the compressed brain expands. This being so, it is obvious that for a successful issue operation must be carried out at the earliest possible moment. If compression is so advanced that both pupils are more or less dilated and fixed, and other signs show that the

Fig. 480. The relative positions of the flaps for the exposure of the anterior and posterior branches of the middle meningeal artery.

Fig. 481. The operation can be undertaken very effectively through a straight incision.

intracranial tension is high, an intravenous injection of hypertonic
saline may be given. With the slight decompressive action of the
injection the veil may be lifted sufficiently to enable us to decide on
which side to trephine.

So long as the blood-pressure remains above normal, decompression by operation offers hope.

Hæmorrhage from the Anterior Branch.—A horseshoe-shaped incision can be used (*Fig.* 480), or, what is better, a straight incision
(*Fig.* 481). Incising the scalp is conducted in a halting manner,
the better to control hæmorrhage. Clip the bleeding vessels; the
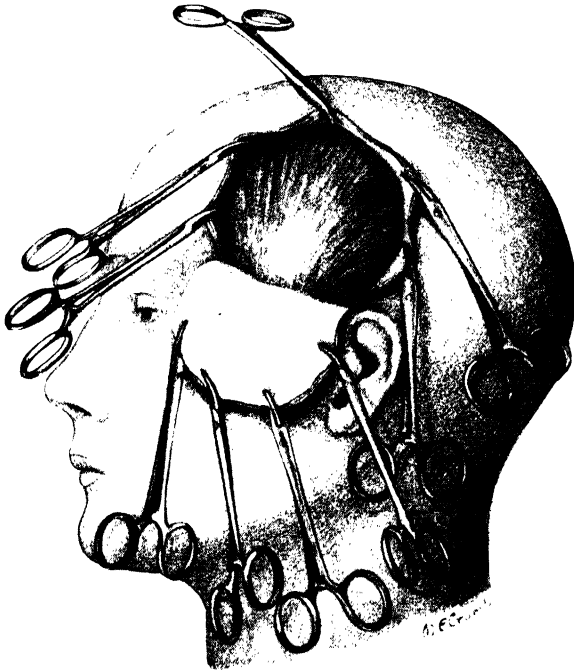
Fig. 482. Subtemporal decompression. The skin incision is made inch by
inch, and bleeding points are caught as they appear. The whole thickness of the
scalp opposite the bleeding point is clipped in a hæmostat.

whole thickness of the skin is caught in the forceps (*Fig.* 482), otherwise difficulty will be experienced in maintaining the hæmostats on
bleeding vessels. The temporal muscle and fascia are now split
vertically and the periosteum cleared on either side.

Apply the pin of the trephine (*Fig.* 483) or the cranial burr to
the marked point of the skull. In using the trephine remember to

remove the pin as soon as a 'bite' has been obtained.   The skull having
been perforated, if the hæmorrhage
is extradural, blood and blood-clot
will be apparent at once.   Enlarge
the opening, mainly in a downward
direction (*Fig.* 484), with nibbling
forceps (*Fig.* 485).   When the open-
ing is adequate, commence removing
the clots with a finger used as a
scoop.   A large-sized Volkmann's
spoon may also be employed for this
purpose, and hot saline may be run
into the wound with the same object
in view.

Take particular notice of the
character of the blood which is evacu-
ated.   If there is no fresh arterial
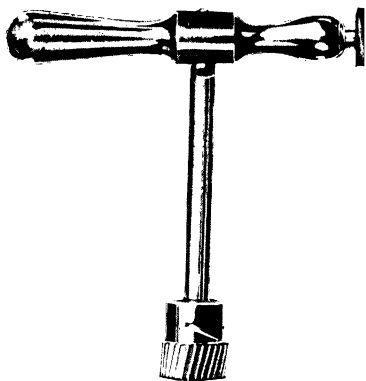
483.—A
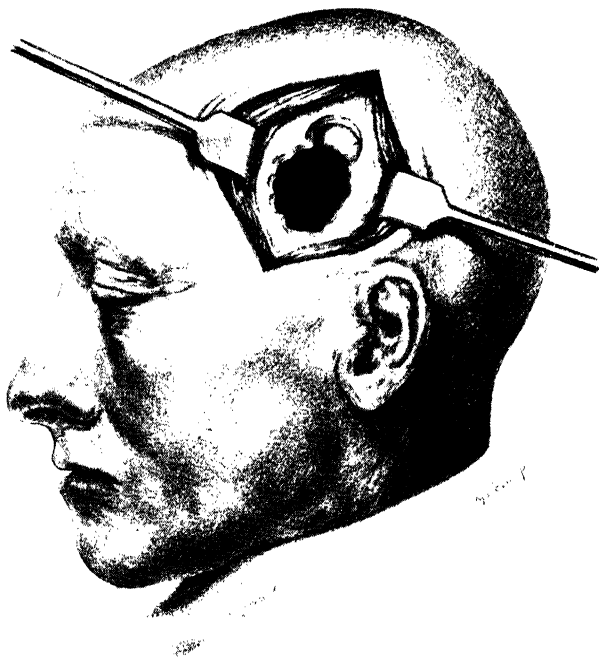
Fig. 484.—Extradural hæmorrhage.   The trephine hole has been enlarged with
nibbling forceps.

blood, it is probable that the bleeding has occurred from one of the venæ comites of the meningeal artery. Wood-Jones has shown that the grooves on the interior of the skull are made by these venous channels and not by the artery, and that in many cases of middle
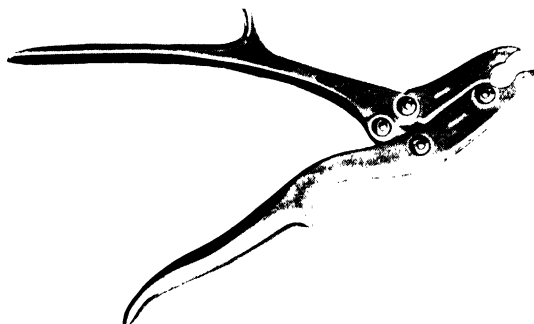
Fig. 485.—A od type of nibbling forceps.

meningeal hæmorrhage it is the venous vessel that is wounded (*Fig.* 486). Once all this clot has been removed, if there is no new hæmorrhage there is no need to hunt for a bleeding vessel ; close the wound with drainage. If there is new hæmorrhage the bleeding vessel must be found and dealt with, an important matter which we will consider in detail.

In the rare event of the bleeding artery being found in a groove in the bone, it may be plugged with a sharpened boiled match-stick, which should always form part of the arma-mentarium in operations upon

Fig. 486. Extradural hæmatoma from a laceration of a *vein* which accompanies the middle meningeal artery. (*After Wood-Jones.*)

the cranium. The artery usually adheres to the dura ; it is a friable vessel which is best dealt with by under-running it with a fine, round-bodied, curved needle carrying a ligature. The dura should not be penetrated.

Hæmorrhage from the Main Trunk.—This presents a more difficult problem.

G. K., aged 25, at 6.30 p.m. fell from a motor lorry on to the pavement, striking his head. Admitted at 7.30 p.m. he was conscious. At 8.30 he vomited twice, and it was noticed that his pupils were slightly irregular. The head was shaved and a hæmatoma was seen on the right side of his temporal region. At 9.0 he quite suddenly lapsed into unconsciousness, and at 9.15, when I saw him, he was deeply unconscious and breathing stertorously. The pupils were grossly unequal—the right large and fixed.

There was bilateral rigidity of the limbs, which were so stiff that they might be described as imparting a sensation of rigor mortis. Without anæsthesia a horseshoe incision was made ; the temporal muscle being split vertically, a fissured fracture of the temporal bone was observed. On opening the skull much blood-clot was found and evacuated. Renewed hæmorrhage was serious, and appeared to be coming from the under surface as opposed to the lateral aspect of the dura. With nibbling forceps the opening was enlarged right down to the level of the infratemporal crest, the dura was lifted up, and the blood poured out. I intended to plug the foramen spinosum with a match-stick, but it was at once apparent that this would be impossible, for the bleeding obscured the view. Using strips of gauze moistened with turpentine, the area was packed for a moment, and after directing a light into the cavity a bleeding vessel was seen on the under surface of the dura. With a fine needle on a holder the middle meningeal artery was under-run ; as soon as the knot was tied the bleeding ceased.
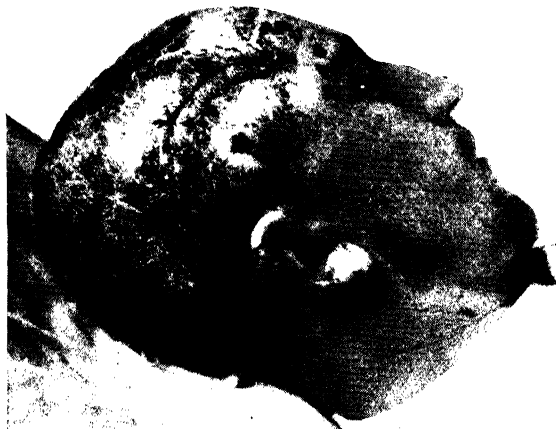
Fig. 487. —G. K., convalescent after ligature of the main trunk of the middle meningeal artery. The skin incision is larger than has been advised in the text. It was so made to encircle a superficial hæmatoma.

The brain expanded well. The wound was closed in layers with drainage. Not until the fourth day did the patient recover consciousness. When seen six months later he had entirely recovered. (*Fig.* 487.)

Bleeding from the main trunk is best dealt with in the manner described above. It is rarely necessary to tie the external carotid, although the possibility of stopping serious inaccessible hæmorrhage by this means should be borne in mind.

Hæmorrhage from the Posterior Branch.—On opening the skull the hæmatoma is found to extend towards the occipital region. Do not go on nibbling away in a posterior direction, a mistake which I have made. As soon as you are convinced that the hæmorrhage arises from the posterior branch, make a second incision (*see Figs.* 480, 481), and apply the trephine at the posterior point previously marked.

Contre-coup.—If the diagnosis of extradural hæmorrhage has been made confidently and no hæmorrhage is found when the skull has been trephined, the possibility of *contre-coup* should be remembered, and generally it is most advisable to explore the other side.

SUBDURAL HÆMORRHAGE

On opening the skull the dura is seen to be tense and plum-coloured, which is the signal that there is extravasated blood beneath.
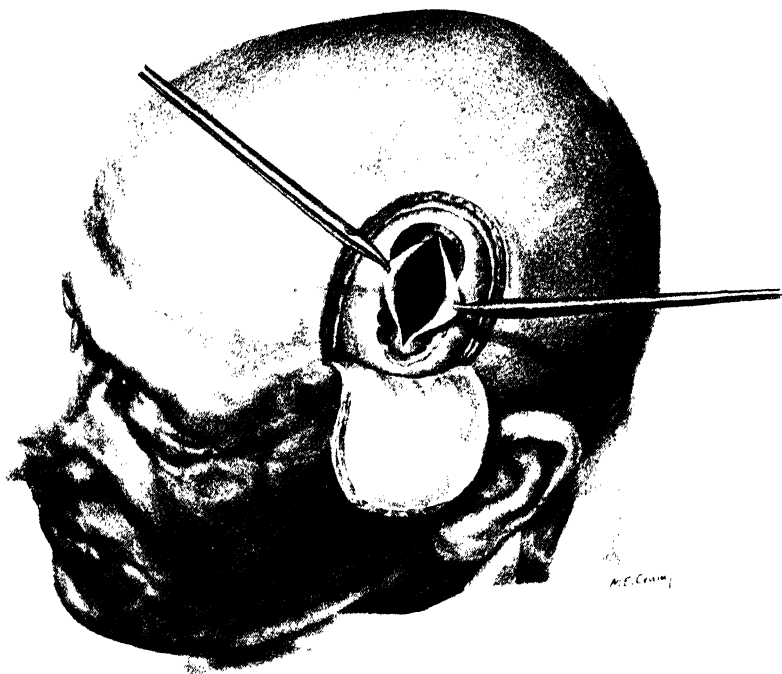
Fig. 488.—Operation for evacuating a subdural hæmatoma. (*After Bathe Rawling.*)

After nibbling away sufficient bone, mostly in a downward direction, prepare to open the dura. Hot, moist towels are placed about the wound so as to cover up every particle of skin, for infection of the pia-arachnoid must be avoided meticulously. If the meningeal vessels cross the exposed area they should be secured by under-running them

with a suture.   Next, pass the point of a fine aspirating needle
connected with a syringe into the lateral ventricle and withdraw
1 or 2 c.c. of fluid.   This will help to lessen tension and make
the next step practicable.   Take an empty, small, curved needle
on a holder and pass the point through the dura.   By these means lift
up the dura and nick it with a scalpel.   The dura can now be opened
in a crucial manner with scissors, and the blood coagulum is dis-
played.   With the finger, aided by a stream of hot saline, remove the
blood-clot (*Fig.* 488).   If necessary enlarge the opening for this
purpose.   It is seldom that the whole of the blood can be removed ;
the length of time spent on removing the clot will be proportional
to the patient's general condition.   When possible the dura is approxi-
mated with interrupted catgut sutures, leaving a tube in the most
dependent part of the wound which is brought out through a stab
wound in the base of the flap.   The wound is closed and a glove drain
inserted at one angle.

The prognosis in these cases is not so gloomy as might be imagined.
True, if there is extensive cerebral laceration there is little hope.
More often the hæmorrhage comes from the pia-arachnoid vessels, and
statistical inquiry shows that operation in this class of injury is
encouraging.   The patient should be given urotropine intravenously
or by mouth to inhibit intradural infection.

WOUNDS OF THE SUPERIOR LONGITUDINAL SINUS

The secretary of a football club fell down the station steps on to the
back of his head.   He received first aid in the form of stitches to a scalp
wound over the occiput, and he was admitted to hospital at 1 a.m.   By
the following morning he had regained consciousness, but was drowsy.   At
4.30 p.m. he again lapsed into unconsciousness, which was complicated by
fits *on both sides of the body*.   The spasms began in the feet, passed up the
legs, and were followed by contortions of the face.   The pulse was 120,
respirations stertorous, and nystagmus marked.   The bilateral nature of
the fits and the central position of the (sutured) cut had made the diagnosis
of injury to the superior longitudinal sinus tolerably certain.   A semi-
circular flap was turned down around the sutured scalp wound.   A fissured
fracture was seen in the middle line immediately above the torcula.   Two
trephine holes were made on either side of the middle line, and the inter-
vening bridge was removed.   Blood could be seen beneath the bulging
dura.   The dura was opened and a thin film of venous blood was seen
flowing over the cerebral hemisphere.   The hæmorrhage was easily con-
trolled by gauze packing insinuated between the dura and the skull in the
middle line.   The blood was mopped up and an attempt was made to close
the dura, which was practically brought together.   A tube was inserted
at the most dependent part of the wound.   The next day the patient was
conscious.   The packing was removed by degrees on the fourth day.   On
the seventh day there was a little renewed hæmorrhage from the wound.
On the eighth day signs of meningitis set in.   Lumbar puncture showed
purulent cerebrospinal fluid.   He died on the tenth day.

The case demonstrates how readily hæmorrhage from the venous sinus is controlled by packing, for it will be remembered that the blood-pressure in the sinuses is almost negligible. I made a grave error. The scalp wound (which had been sewn up at a first-aid station) had not been excised, and this was forgotten. If the wound had been excised and disinfected with iodine, as is our routine in the first instance, it is improbable that infection would have supervened. Under the circumstances it would have been wiser not to have opened the dura.

Hæmorrhage from the superior longitudinal sinus usually gives rise to subdural hæmorrhage. If there is a demonstrable wound this may be stitched by passing the needle through the dura and the vein wall. Any oozing from the stitch-holes can be quelled by applying a piece of muscle to the area for a few moments. Another satisfactory method of dealing with a wound of the superior longitudinal sinus is to cover it with a 'postage stamp' of fascia lata. The bleeding is controlled by packing until a piece of fascia lata has been obtained from the thigh. This 'postage stamp' is laid over the sinus and held there for a few moments. The graft usually adheres to the dura and hæmostasis is complete.

The Lateral Sinus. —The same principles apply to wounds of the lateral sinus.

A. Ricard's Case :—

The patient was brought in unconscious with signs of a fractured base. Bleeding was occurring from the left ear. The next day the pulse became slow, the left pupil was larger than the right, and there was œdema of the left fronto-parietal region. Operation was decided upon. On opening the skull dark blood-clot was seen and evacuated. The meningeal artery was found to be intact. Enlarging the cranial defect posteriorly, profuse bleeding was seen coming from the angle of the lateral sinus. This was controlled by packing tightly with strip gauze between the dura and the skull. The wound was closed, leaving the end of the gauze protruding from the posterior angle of the wound. On the sixth day an attempt to remove the gauze resulted in further hæmorrhage. The packing was re-inserted *and was not removed until the twenty-first day.* Recovery.

DEPRESSED FRACTURES OF THE SKULL

Simple Depressed Fracture. —In cases of simple, as opposed to compound, depressed fractures it is not always necessary to operate at once. If the depression is in a relatively safe area, e.g., the frontal region, and there are no focal symptoms, it is sometimes advantageous to delay operation for twenty-four hours or so, in order that the patient may recover from the shock of the accident. The differential diagnosis between an epicranial hæmatoma and a depressed fracture is sometimes impossible. If this difficulty arises, it is better

to explore; in those cases in which the diagnosis is uncertain, operation usually reveals a hæmatoma.

Make a wide semicircular incision about the depression. When the depression is situated on the crown of the head — i.e., where the application of a tourniquet will not impede the work—the following practical and refined technique may be employed. Sterilize a long piece (two feet) of new $\frac{1}{4}$-in. drainage tube, which makes a good tourniquet. Cover the head with a sterile towel, and having drawn the towel very tightly over the skull, apply the tourniquet over it (*Fig.* 489) The depression can be felt through the towel, and a semicircular flap can be made through towel and scalp, right

Fig. 489.—Operation for a depressed fracture. A tourniquet is applied over a sterile towel. A horseshoe-shaped incision is made about the depression through the towel and the scalp.

Fig. 490.—In depressed fracture always trephine sound bone. (*After Bathe Rawling.*)

down to the bone, with one sweep of the knife. When the depression
is placed laterally, an inconvenient place for the tourniquet, make the
horseshoe-shaped incision inch by inch, clipping the whole thickness
of the scalp in hæmostats where spurting vessels are encountered.

Fig. 491. —Elevating a depressed fracture.
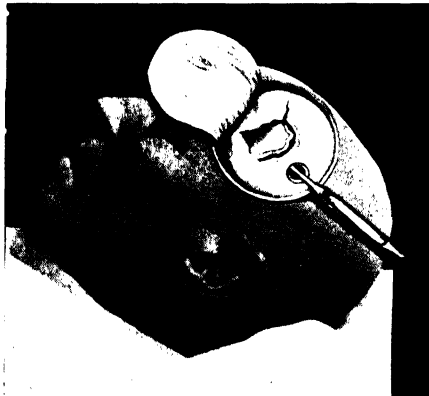
Fig. 492.—Method of elevating a depressed fracture. In this case the depressed
fragment is quite loose, and should be removed.

This will conserve blood. Having cleared the periosteum from the
bone, examine the fracture. It is usually necessary to trephine, the
exception being where there is considerable comminution and a piece

of loose bone can be readily picked up with dissecting forceps and removed. *Always trephine sound bone* (*Fig.* 490) is an axiom which can bear much repetition. Via the trephine hole the depression may be elevated. If it comes up nicely into position (*Fig.* 491), this is all that is necessary. If not, the depressed fragment must be removed (*Fig.* 492). A certain amount of common sense must be used in deciding whether a fragment should be removed or left. The following case may be helpful in emphasizing this point.

W. P., aged 6, was knocked down by a motor-car, and recovered consciousness in the ambulance on the way to hospital. There was a depressed fracture in the right temporo-parietal region. The diagram made at the time of the operation (*Fig.* 493) is self-explanatory.
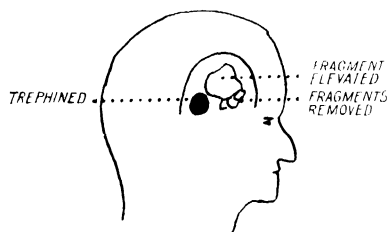
Fig. 493. Facsimile of the diagram which accompanied the case of W. P.

Small detached fragments should always be removed entirely. They are prone to give rise to sequestra if replaced. When operating for depressed fracture it is advisable to have ready a fine, round-bodied curved needle charged with a cat-gut ligature and mounted on a holder, for when the depressed fragments are removed, haemorrhage may take place from the middle meningeal artery, the longitudinal sinus, or the lateral sinus, as the case may be. A wounded sinus can be repaired by the 'postage stamp' method already referred to (p. 487). The artery can be secured by under-running it. It is generally advisable to drain the wound for twenty-four hours.

Compound Depressed Fracture.—The urgency of this condition is extreme. The wound should be excised and the interior disinfected. It is usually more convenient to excise, sew up this wound, and then make a horseshoe-shaped incision about the depression. The treatment of compound depressed fracture, once the wound has received attention, differs a little from the closed variety. Morison's B.I.P.P., lightly smeared over the interior after fragments have been removed, is useful. This preparation can also be used to stop oozing from the diploë. For the latter purpose it is even better than Horsley's wax. The following case of compound depressed fracture presents some unusual features : -
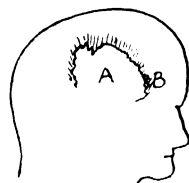
Fig. 494. Facsimile of the diagram which accompanied the case of D. M.

D. M., aged 26, was admitted with an extensive head wound, following the explosion of a soda-water fountain. On turning down the flap after excision of the scalp wound, the condition shown diagrammatically in

Fig. 494 was seen. The area **A** was found over-riding the rest of the skull. Brain substance was issuing from **B**. Nibbling forceps were taken, and, commencing at **B**, the over-riding portion was nibbled away, especially in front. The patient's condition became alarming. The flap was replaced and sutured with a continuous mattress stitch of thick silk. A drainage tube was inserted and a glove drain to **B**. After the third day the patient made an uninterrupted recovery.

Penetrating Wounds of the Brain.—The principles involved in the treatment of this very rare civil accident will be referred to briefly. They are culled from Harvey Cushing's classical writings on gunshot wounds of the head.
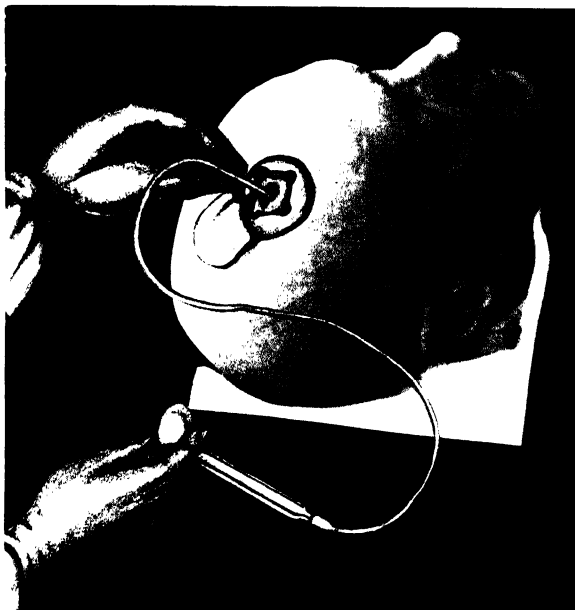
Fig. 495. Method of dealing with a penetrating wound of the brain. (*After Cushing.*)

The wound is excised, using a tripod incision (p. 473). The area of cranial penetration is removed *en bloc* rather than piecemeal. Four holes are bored with a burr or small trephine so as to form a square on the outskirts of the cranial wound. By using a Gigli's saw the quadrilateral piece of bone with the penetrating wound in the centre is removed. The edges of the laceration of the dura are trimmed. The brain wound is not explored with the finger, but a rubber catheter is passed in. The latter may be fastened to an aspirating syringe (*Fig.* 495). A bullet should not be removed unless it is perfectly accessible. The wound is closed with adequate drainage.

POND DEPRESSED FRACTURE

P. D., aged 5 months, was admitted with a depression two inches in diameter in the right parietal region. A few hours previously he had fallen
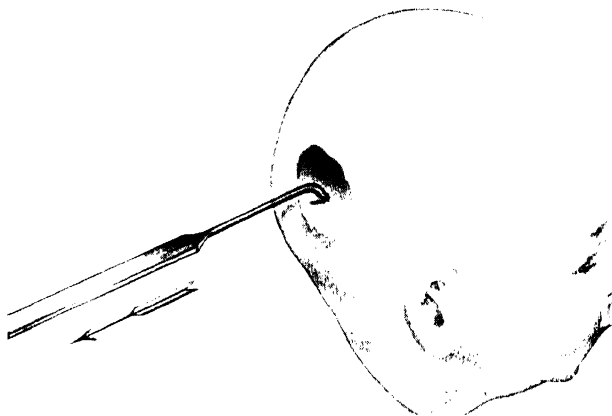
Fig. 496.   )d of deali)   with a pond depressed fracture described the text.

against the knob of an oven door. The infant was anæsthetized. A tiny incision was made over the centre of the depression right down to the bone. The skull was penetrated by a gimlet, and a blunt aneurysm needle was passed in. Traction was applied (*Fig.* 496). The depressed area sprang out.

Fig. 497. Silk wound around gimlet. Used to perforate skull in a pond depressed fracture.

One skin suture was all that was necessary to close the wound. Three months later the child was perfectly well and his cranium presented a normal appearance.

An ordinary carpenter's gimlet with silk wound round to within a quarter of an inch of the point (*Fig.* 497) makes a very good perforator. After the silk has been wound the gimlet is sterilized in the usual manner. In a fully equipped hospital I was not able to find an instrument more suited to the purpose.

FRACTURES OF THE BASE

In the first instance the routine outlined under CONCUSSION (p. 475) is followed. If blood or cerebrospinal fluid is issuing from the ear, the discharge is mopped up at intervals with sterile wool;

the ears should not be plugged. Conversely, if cerebrospinal fluid
and blood are coming down the nose, Forrester recommends plugging
the nares with sterile cotton-wool soaked in mercurochrome solution.
When intrameningeal contents are leaking externally it is obvious
that the patient is in imminent danger of ascending meningitis. To
attempt to prevent this urotropine is indicated. Intravenous uro-
tropine is strongly advocated by Tytgat; 5 c.c. of a 40 per cent
solution is supplied in ampoules by Schering. This is certainly a
good method of getting urotropine into the circulation. It is soon
excreted in the cerebrospinal fluid.

The treatment of fractured base is largely symptomatic. In-
creased intracranial tension is reduced by one of the methods described
already. Magnesium sulphate per rectum is the best, but if this is
not tolerated, daily lumbar puncture is extremely effective. About
10 c.c. of cerebrospinal fluid are removed at each puncture. Sub-
temporal decompression for fractured base is hardly ever called for.
One should bear in mind that persistent bleeding from the ear may
be due to middle meningeal haemorrhage, which decompresses itself
by this route. Bathe Rawling first called attention to this pheno-
menon, and in this instance exploration is more than justified.

If the patient is restless, the question will arise as to the best
drug to prescribe. If the diagnosis of fractured base has been made
and there is no question of concealed haemorrhage, morphia can be
given with advantage. Paraldehyde per rectum often produces rest-
ful sleep.

INTRACRANIAL INJURIES IN THE NEWBORN

Intracranial injuries in the newborn are common, and they are
commencing to receive the attention they deserve. There are usually
respiratory difficulties from the onset, deepening somnolence, and
recurrent vomiting. The fontanelle is found to be bulging, twitch-
ings of the face and limbs are frequent, and failure of respiration
with attacks of cyanosis are a constant feature. In all cases, if there
is the slightest suggestion of an intracranial haemorrhage in the new-
born babe, 10 c.c. of the mother's blood should be injected into the
infant intramuscularly. Alan Moncrieff recommends the early exhibi-
tion of hypertonic rectal saline in such cases. Two to three ounces
of a 10 per cent solution, i.e., one teaspoonful of salt in two ounces
of water, are run slowly into the rectum. The nurse then holds the
buttocks together in order to retain the solution as long as possible.
Injection can be repeated at four-hourly intervals. Just as in the
treatment of other cases of head injury, absolute rest is essential;
the baby must not be lifted out of bed for any purpose. Feeding is
carried out with milk expressed from the mother's breasts. Chloral

in half-grain doses is prescribed if restlessness or twitching is present. Five per cent carbon-dioxide in oxygen through a nasal catheter is of value for failure of respiration.

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CHAPTER XXXI

THE FACE, MOUTH, AND NOSE

FACIAL CARBUNCLE

CARBUNCLE of the face has a sinister reputation, and the upper lip is the most common site of this dreaded lesion. A complication which quite frequently heralds the oncoming of a fatal pyæmia is thrombosis of the cavernous sinus. It is now becoming increasingly recognized that to incise, squeeze, scrape, or otherwise interfere with a carbuncle of the lip itself is the essence of meddlesome surgery, but to inject whole blood *around* the carbuncle (*see* Chapter XLIV) does not come under this nefarious category.

In a series of 15 consecutive cases of thrombophlebitis of the cavernous sinus, I found that 4 were due to a furuncle or carbuncle of the upper lip, and that 3 more originated in an infected gnat-bite of the nose.

Ligature of the Angular Vein as a Preventive Measure in Facial Carbuncle.— To forestall the spread of infection by this route, ligation of the angular vein is a sound proposition; when performed under local anæsthesia it is free from danger. If necessary, both angular veins are ligated.

It is desirable to have some guide as to the most opportune moment for this intervention, for it is obvious that the resistance of the patient is sometimes enough to keep the infection within bounds. On the other hand, the necessity for timely interference must always be before us. On the whole, it is better to err on the side of activity. A sign which foretells impending danger is œdema spreading from the lip to the inner canthus, and this is usually found in the presence of suffusion of the eyelids. As far as my own observations have gone, the premonition is invariably unilateral. If in addition to this sign there is considerable elevation of temperature, the call for action is imperative.

Technique.—If there is any suggestion of delirium, it is advisable to administer a hypnotic twenty minutes before operation. Castor oil should be introduced into the eye, and a damp gauze covering applied over the lids, to prevent iodine running into the conjunctival sac. The lip is covered with gauze wrung out in perchloride solution; dry gauze becomes easily displaced. The angle made by the junction of the nose with the cheek is the surface marking for the vein. After

novocain has been infiltrated, an incision is made commencing a little
below the inner canthus and passing downward and very slightly out-
ward for about one inch. There is always much troublesome oozing,
which can be quelled by packing with gauze soaked in adrenalin. After
more novocain has been injected, dissection in the wound will reveal
the levator labii superioris alæque nasi. The fibres of the muscle are
teased apart, and the angular vein will be found either in or beneath
this muscle (*Fig.* 498). It is divided between ligatures. Skin sutures
and a collodion dressing complete the operation.
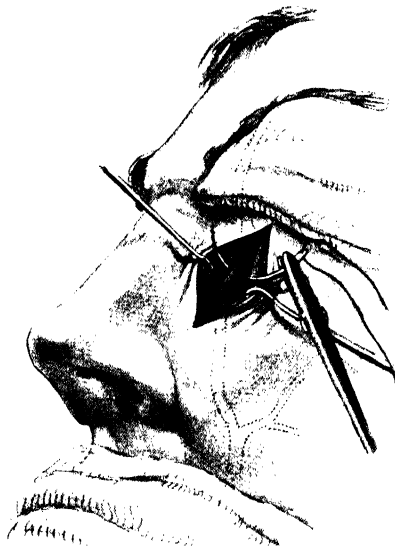
Fig. 498.—Ligature of the angular vein.

A girl, aged 16, complained of a large carbuncle which had begun nine
days previously as a pimple on the middle of the upper lip, and which had
developed into a carbuncle of both upper and lower lips. It had become
much worse forty-eight hours before admission. Examination showed
an œdema spreading toward the right eye, with great suffusion of the eye-
lids. Her temperature was 103° to 104°, associated with mild delirium.
Ligature of the right angular vein was performed and intravenous mercuro-
chrome was administered. This was followed by local treatment of the
carbuncle with hot magnesium sulphate fomentations. Rapid improve-
ment resulted, and the patient was discharged eleven days later (*Fig.* 499).

Thrombophlebitis of the Cavernous Sinus.—Once thrombophlebitis (*Fig.* 500) has commenced, we are confronted with a condition where, with expectant treatment, practically all cases die (*Fig.* 501).

Fig. 499. Carbuncle of the upper lip: **A**, Twelve hours after ligature of angular vein: **B**, Same, one week later; **C**, Same, one month later.

It happens that I have seen a patient recover, but she is quite blind in both eyes—a sorry tribute to inactivity. As long as the patient is young and the proptosis unilateral, we should at once carry out
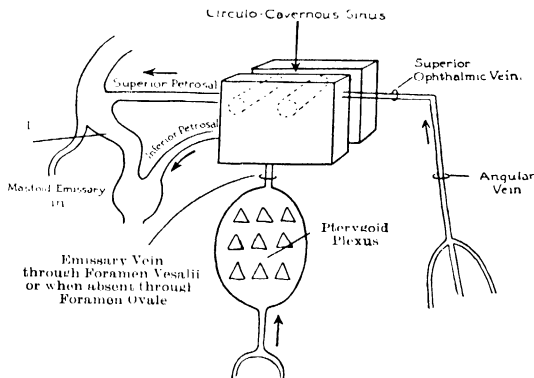
Fig. 500.—The cavernous sinus and its connections (diagrammatic). (*By courtesy of the ‘Clinical Journal’.*)

Eagleton's highly original and, in his hands, successful combined operation, though it requires courage to remove an eye which is not yet blind.

Eagleton's Combined Operation.—

1. The common carotid artery is ligatured (*see* pp. 525, 526). This (*a*) puts at rest the beating internal carotid and gives rest to the cavernous sinus, and (*b*) renders comparatively avascular the area next to be attacked.

2. The eyeball is enucleated. Eagleton's studies show that pus is found at the apex of the orbit in a proportion of cases, and it is perfectly conceivable that if the case is an early one these measures may suffice. Before concluding the operation the ophthalmic vein must be inspected. If this vein is filled with purulent clot the cavernous sinus itself may be drained by enlarging the sphenoidal fissure.

Fig. 501. Carbuncle of upper lip. Thromb of left cavernous sinus. Death resulted.

WOUNDS OF THE FACE

Wounds of the face, thanks to the liberal blood-supply, heal readily. The surgeon's chief aim is to avoid an ugly scar. Wound edges should be pared most carefully; ragged and contaminated pieces of subcutis are snipped away with scissors, the actual skin level being preserved as far as possible. The suture material should be of the finest, and the needle a small, round-bodied one.

A method of coapting the skin which can be recommended is as follows. Lightly swab out the wound with tincture of iodine. Insert a fine suture at each end. While the assistant exerts moderate tension by means of these sutures the cut edges are coapted with van Herff's serrefines (*Fig.* 502). The only dressing needed is a strip of gauze tucked under the clips on each side of the wound. The scar resulting from this method is the most perfect possible.
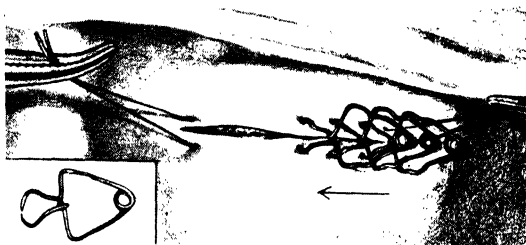
Fig. 502. Method of closing a wound with van Herff's clips. (*Inset.* One of the clips.)

In complicated cases the surgeon will have to exercise ingenuity to suit the circumstances.

Wounds of the Lip.—Hæmorrhage can be controlled at once by picking up each side of the lip between a finger and thumb (*Fig.* 503).

Fig. 503.— Method of controlling the hæmorrhage and holding the parts to be approximated in a split lip.

The coronary artery can then be secured on each side. After the cut edges have been pared, pass a stitch at the junction of the skin and

Fig. 504. Repair of a split lip. The stay suture is inserted first and this

per
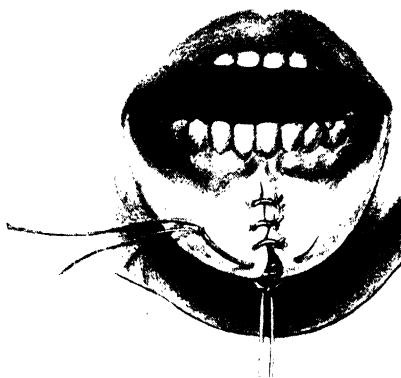
the red margin. Leave the ends long, and these will act as a convenient retractor. By lightly pulling on the suture in a downward direction the lip may be everted, when the mucous membrane is stitched together with catgut (*Fig.* 504). The remainder of the red margin is then brought together with the finest silkworm gut or horsehair. The skin is approximated with clips or silkworm-gut sutures.

Laceration of the Pinna.—Suture the cartilage and then approximate the skin on each aspect. It has been found that large portions of the pinna hanging merely by a fragment of tissue prove viable after accurate suture.

Wounds of the Eyelids.—*See* p. 782.

DEPRESSED FRACTURE OF THE ZYGOMATIC ARCH
OR THE MALAR BONE

Depressed fractures of the zygomatic arch and the malar bone are elevated readily if operation is undertaken soon after the accident. The position of the bones can be adjusted satisfactorily under local anæsthesia. Infiltrate the region with novocain. In the case of the zygomatic arch the method employed is shown in *Fig.* 505. The teeth of a pair of tenaculum forceps or a towel clip are thrust through the skin around the deep surface of the arch. By steady traction the arch is elevated to the normal level. In the case of the malar bone a tenaculum forceps or towel clip with roomy curved teeth is opened widely. One tooth pierces the skin and transfixes the bone at the outer margin of the orbit. The other passes deep to the inferior surface of the malar bone. When a good hold has been obtained elevation can be accomplished.

Fig. 505. —Elevation of a depressed fracture of the zygomatic arch under local anæsthesia.

REDUCTION OF A DISLOCATION OF THE LOWER JAW

Kennon's method is as follows. Bandage your thumbs, and over the bandage wind adhesive tape. The patient lies upon a couch and the operator stands behind the head. Insert the thumbs into the mouth so that their pulps lie on the molar area, while the fingers are insinuated around the angle of the jaw (*Fig.* 506). Very slowly exert pressure through the extended arms. This tires out the temporal and masseter muscles, and by depressing the back of the jaw and lifting the chin, reduction can generally be accomplished. In difficult cases anæsthesia will be necessary.

Fig. 506. Reducing a dislocated jaw.

FRACTURE OF THE LOWER JAW

The usual sites of fracture are shown in Fig. 507. The immediate treatment is to apply a four-tailed bandage. As soon as convenient

Fig. 507. Usual sites for fracture of the lower jaw in order of frequency: 1, The most common site; 6, The rarest.

a more efficient and permanent form of splint must be constructed. If the patient has sufficient teeth, intermaxillary wiring is eminently

satisfactory. This method has many advantages over the dental cap splint, not the least being that it is unnecessary to take impressions and casts of the jaw.

Treatment by Intermaxillary Wiring.—Procure some copper wire, gauge 22, or, if this is unobtainable, silver wire of the same size may be used. Copper wire has certain advantages, and if it can be obtained, so much the better. Some silver wire, gauge 24, is also necessary. Taking the thicker wire, make six wire pins, each four inches long, of the shape shown in *Fig.* 508. The free ends of these pins are pointed by cutting the wire obliquely. Put these six pins and the finer wire with the instruments to be sterilized.

Fig. 508.—Wire pin for intermaxillary wiring.

A general anæsthetic is usually advisable, but is not always essential. *If a general anæsthetic is to be employed, be certain that the stomach is quite empty.* The danger of post-operative vomiting when the mouth cannot at once be opened will be obvious to all.

The principle involved is to wire the lower jaw to the upper on either side of the fracture. This entails having four fixed points, two on the upper jaw and two on the lower. Each of these fixed points is constructed in the following manner. One wire pin is threaded
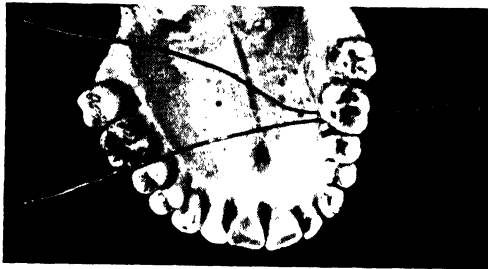
through the space between two teeth, in the manner shown in *Fig.* 509, so that the eyelet is on the labial side. The free ends of the pin are brought back through the interdental spaces immediately in front of and behind the original penetration. The wire is twisted until it grips the teeth firmly. Excess of wire is cut off, and the twisted knot is pressed and tapped until it lies flat (*Fig.* 510). The first fixed point is made behind the fracture, the second in front of the fracture ; the third and the fourth, which are in the upper jaw, are made to lie as nearly as possible opposite the first and the second.

We are now ready to bolt the lower to the upper jaw. A double strand of the finer wire is passed through the opposing loops and gradually tightened (*Fig.* 511). Before the final tightening the fracture is manipulated into the best possible position, and is held by the assistant until the tightening is completed. The twisted ends are

Fig. 510. Bringing back the ends of the pin between the adjacent teeth. The inset shows the wiring of one of the fixed points completed.

pressed down so as not to impinge upon the buccal mucous membrane.

After-treatment.—Contrary to what might be thought, the patient almost at once learns to take a liquid diet, either through a straw or directly from a cup. The liquid diet can be varied, and should contain some fruit juices and soups as well as preparations of milk. With such a diet the patient will thrive. After each feed an antiseptic mouth-wash must be used, and twice a day a powerful spray is applied to the teeth. If the fracture involves little or no loss of bone substance, the wires should not be removed for six weeks. A longer period may be necessary, and this in part will be determined by the X-ray. An anaesthetic is not necessary for the removal of the wires. The wire does not loosen or destroy sound teeth.
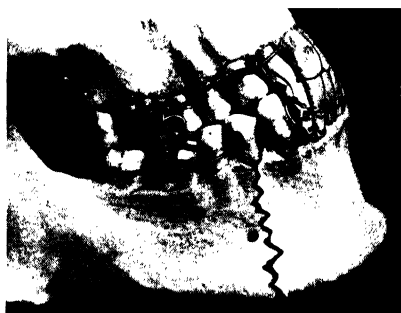
Fig. 511. The wiring complete.

Treatment when the Patient is Edentulous.—A dental surgeon should be consulted. If he considers that it is possible to construct an internal vulcanite splint which will hold the fragments in position, so much the better. Alternatively, an open operation must be

performed. The mouth must be rendered as clean as possible with sprays and mouth-washes for forty-eight hours, during which time the skin over the jaw also receives thorough attention. An incision is made along the lower border of the jaw, the periosteum is lifted up, and after the fragments have been manipulated they are held firmly in position by the assistant while they are bolted into place with a small bone-plate.

Fractured Mandible with External Wound.—

B. A., aged 15, was brought to hospital with a lacerated wound of the skin through which protruded one segment of a completely fractured lower jaw. The wound was grossly contaminated with road dirt. Under evipan anæsthesia the wound was excised and disinfected. A loose piece of alveolus and several teeth were removed. Two holes were drilled and the fractured surfaces were brought into apposition with a silver wire. The twisted ends of the wire were left jutting into the wound, which was sutured partially. The wire was removed six weeks later. There was very little suppuration and good union of the mandible occurred.

TRISMUS

Severe trismus may complicate inflammatory processes in the neighbourhood of the temporo-maxillary joint. Chief amongst these is an erupting wisdom tooth or a dental abscess connected with that tooth. When the cause of the trouble is obscure a radiograph is often helpful.

Treatment.—The first step is to drain the abscess or remove the offending tooth. Under the anæsthetic the jaw can be opened and a prop can be left in between the teeth. Once the focus of infection has been dealt with, usually trismus is transitory. In its more chronic forms the jaws must be prised apart gradually. For this purpose a common clothes-peg is useful. The ends of the clothes-peg are whittled down with a knife so as to take the form of a wedge. It is always possible to separate the jaws for a millimetre or two, and the end of the wedge is firmly pressed between the front teeth. The peg is left in position for hours at a stretch, and by its continual pressure the amount of separation increases. As soon as there is about a quarter of an inch of separation a clothes-peg of the spring type (*Fig.* 512) is substituted. A transverse notch is

Fig. 512.—Clothes-pegs are useful for maintaining continuous pressure on the jaws in trismus.

cut on either side to accommodate the edges of the incisors. The peg is left in position for long periods, and gradually but surely the amount of separation increases.

Trismus due to tetanus is dealt with in Chapter **XLIII**.

ACUTE SUPPURATIVE PAROTITIS

Post-operative parotitis is now infrequent. In the early days of abdominal surgery the importance of preparatory and post-operative oral hygiene was not appreciated. Furthermore, the patient was forbidden to drink for several days. These circumstances favoured an ascending infection from the parched infected mouth along Stenson's duct to the parotid gland, and acute parotitis became a dreaded and often fatal complication. Bond, of Leicester, showed conclusively that pigment particles, and therefore bacteria, could *ascend* along the lumen of Stenson's duct.

If infected parotitis threatens, no effort should be spared to cleanse the mouth and prevent reinfection of the duct. Boroglycerol is a useful adjunct in this respect. A sialagogue in the form of chewing gum is also useful. W. Meyer finds that infections of the parotid gland respond exceptionally well to hyperæmia, and he induces artificial hyperæmia by placing an elastic band around the neck. The band is worn for as much as ten hours per diem. Such treatment is sometimes rewarded by resolution of the inflammation.

When treating acute suppurative parotitis whether post-operative or not, it is important *not to wait for fluctuation*, for pus may lie deeply beneath the parotid fascia. If the symptoms continue for four days and the swelling increases, if the overlying tissues become œdematous, or the temperature becomes high, incision is indicated whether fluctuation can be obtained or not.

A transverse incision should be made over the point of greatest prominence, having due regard to the situation of the branches of the facial nerve and Stenson's duct. The parotid fascia should be incised freely and not opened by Hilton's method (Bucknall). The little finger is introduced in order to break down interlobular septa. Under-drained loculi will continue to burrow and lead to fistulæ and other troubles.

In fulminating cases, indeed in most of the examples which require surgical drainage, I think it advisable to decompress the whole parotid by the effective method designed by Blair. An incision is made in front of the ear; it is a long incision extending from the zygoma to the angle of the jaw (*Fig.* 513), and in necessary cases it can be extended into the neck. It passes down to the parotid fascia. The anterior edge of the skin is undercut and pulled forward, thereby exposing practically the whole of the parotid (*Fig.* 514). The capsule is incised

transversally, if necessary in several places. Special care is taken
not to injure the two branches of the seventh nerve leaving the parotid
gland at its anterior border (*Fig.* 514). If pus does not flow blunt-
nosed forceps are thrust within and their edges opened. The method
spares the facial nerve and allows a virulently inflamed parotid room
to expand. The wound is left open and packed with gauze soaked
in flavine.

Fig. 513. Showing Blair's incisio
fulminating parotitis.

Fig. 514. When the
undercut nearly the whe
can be displayed.

ALVEOLAR ABSCESS

The pain associated with alveolar abscess is intense, the consti-
tutional symptoms are often severe, and with incorrect treatment
the period of invalidism is considerable. At times it is difficult to
decide which is the offending tooth. Where facilities exist a radio-
gram is very desirable. If rarefaction can be demonstrated around
the roots of one tooth we can be confident of the exact location of
the mischief.

Removal of the tooth, so satisfactory if performed at the right
time, may aggravate the disease. When spreading osteomyelitis
follows extraction the dental surgeon is sometimes unfairly blamed
for using unsterile instruments. In reality it is probably yet another
example of an old story. Dental abscess may be compared with
appendicitis. If the offending tooth is removed early in the course
of the disease the attack is cut short. Then follows a period of time

during which any form of surgical interference may result in a spreading infection. Unlike appendicitis, resolution (as a reward for intelligent inactivity) does not frequently occur, but drainage of a dental abscess is followed by rapid convalescence. Armed with the knowledge of this principle, if the patient is seen within twenty-four hours of the commencement of the attack, and, after a thorough intrabuccal examination, the signs of a localized collection of pus are not obvious, advise conservative treatment in the first instance. Hot fomentations and poultices of all kinds should be avoided, for they tend to favour the pointing externally of an alveolar abscess, which is the very thing we wish to avoid. Order hot antiseptic mouthwashes. Dover's powder will relieve pain and induce sleep. When a local swelling can be palpated, drain the abscess into the mouth either by removing the tooth or by incising the mucous membrane and the underlying periosteum, or both. The technique of the procedures are described in detail below.

Fig. 515. Alveolar abscess pointing externally. An external incision should be avoided when possible.

If the case is first seen when the abscess is pointing externally, or if internal drainage has failed—a rare event—then an external incision must be made. When possible, design this incision to lie in the shadow of the jaw (*Fig.* 515).

Methods of Opening an Alveolar Abscess.—Gas anæsthesia or evipan is used.
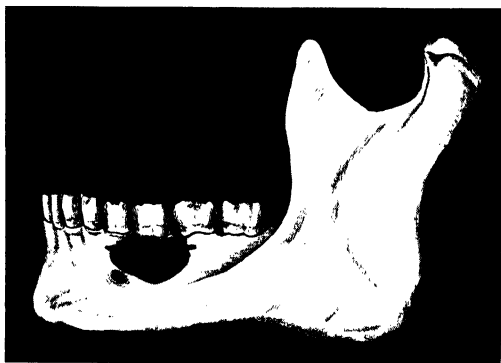
Fig. 516. — Horizontal incision for opening an alveolar abscess of the lower jaw. If necessary, the vertical limb is made. On the lingual side of the jaw the vertical limb must never pass below the horizontal for fear of wounding structures on the floor of the mouth.

Method 1.—Open the abscess by extracting the offending tooth. If this is followed by a gush of pus, we can rest assured that every thing will go on satisfactorily.

Method 2. Open the abscess into the mouth by incising the periosteum. It should be noted that the periosteum must be incised. The incision may be made either on the labial or the lingual side of the alveolus. The point of the knife is carried down to the bone, and the cut is made parallel to the alveolus. In exceptional cases when a flow of pus is not obtained, the incision in the case of the lower jaw is converted into a + on the labial side (*Fig.* 516): on the lingual side, however, a ⊥ only is used, for a downward stroke of the knife below the first cut would endanger structures on the floor of the mouth, notably the lingual nerve. In the case of the upper jaw, the incision may be enlarged cautiously, particularly in an upward direction, with the points of a hæmostat. When a drainage tube is thought necessary—and this will be the case in the upper jaw with a pocket of pus running upwards towards the malar bone a self-retaining tube (*Fig.* 517) will be of service. The after-treatment consists of hot antiseptic mouth-washes.
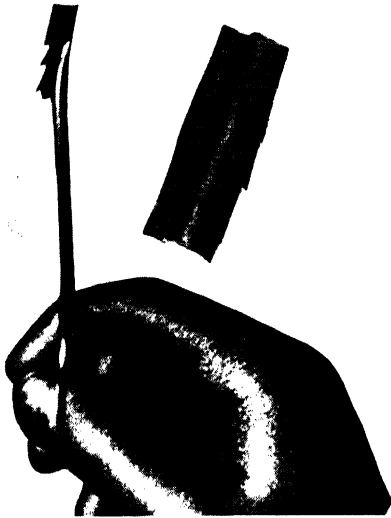
Fig. 517.- Self-retaining tube of corrugated rubber. The imbricated openings are made by cuts with scissors. It is inserted in the manner shown.

REIMPLANTATION OF DISLODGED FRONT TEETH

Reimplantation of a tooth which has been knocked out is occasionally very successful.

S. G. Yates, of Ross, was confronted with a boy who had lost a front tooth on the road near by. A search was made and the tooth was retrieved from the mud. After the tooth had been cleansed and its root treated it was replaced in its socket. Twenty years later the patient was examined and the tooth was still in place.

The dislodged tooth should be cleansed and kept in normal saline. It is desirable to obtain the services of a dental surgeon who

can treat the root and construct a cap splint. A successfully reim-
planted tooth does not live; an ankylosis is said to occur, but
normal gomphosis is impossible. Before attempting reimplantation
the tooth should be examined. If the root is fractured, replacement
is worse than useless. A healthy mouth and a young subject are
also essential to success.

EXTRACTION OF TEETH*

The only instruments required are shown in *Fig.* 518.

Application of Forceps.—In every case one blade of the forceps
should first be placed upon the palatal or lingual side of the tooth.
Having lightly grasped the tooth in the jaws of the instrument
(*Fig.* 519), the beak is pushed upwards or downwards as far as possible,
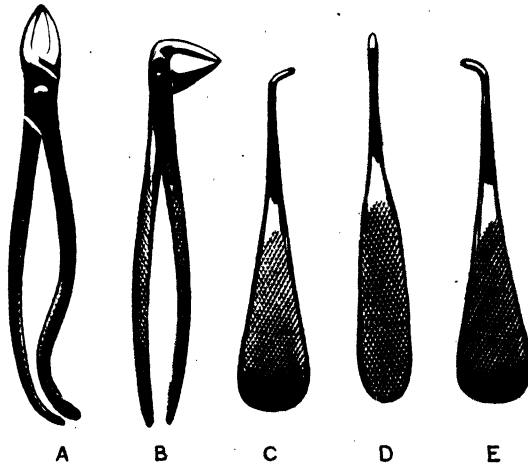
Fig. 518.—The only instruments necessary to extract any tooth. **A**, Uni-
versal upper forceps; **B**, Hawk-bill universal lower forceps; **C**, Right curved
elevator; **D**, Straight elevator, for removal of impacted third molar; **E**, Left
curved elevator.

care being taken to avoid inclusion of the gum or alveolar process.
Thus a firm grasp of the base of the tooth is obtained. If the grasp is
not firm and the crown is weak it is liable to break off, and difficulty
may be experienced in removing the roots. A crown, however weak,
should guide the forceps into their proper position for extraction.

In the case of all incisors and the lower premolars slight *rotatory*
movements are required to loosen the tooth, these roots being conical

* Written with the help of Norman Haines, L.D.S.

in shape. In the case of the remaining teeth a *lateral* movement is required. The upper first premolar is perhaps the most difficult to extract and is the most liable to break.

Extraction of Teeth from the Upper Jaw.— In removing upper molars the inner beak of the forceps should be placed between the alveolar process and the single palatal root. The outer beak is placed between the alveolus and the stronger of the two buccal roots. *It should never be placed between these two roots.* The lateral movement should be slightly in and greater out ; this movement is continued until the tooth is loosened. Extraction must be effected in an outward direction. Great care should be used to prevent pushing a root into the maxillary sinus.

Elevators are not generally used on upper teeth, but may occasionally be used with advantage to extract a difficult third molar.

Extraction of Teeth from the Lower Jaw.— For all lower teeth the hawk-bill forceps is applied. For the right lower molars the operator stands behind and to the right of the patient, the thumb and forefinger of the left hand being placed on the tooth to be extracted—this acts as a guide for the forceps. For the remaining lower teeth the operator stands in front.

The lower incisors are easily removed. The tooth should be firmly grasped and an outward movement made—this also applies to the lower canines. The lower molars differ from the upper by having only two roots. It is, however, very

Fig. 519.— Method of holding dental forceps.

necessary to apply the forceps to one or other of these roots ; never apply them *between* the roots. The third molar, or wisdom tooth, is slightly different from the others, as the roots in this case are generally clubbed together ; this tooth is as a rule easy to extract.

Elevators.—These are employed in extracting difficult lower molars and roots, and prove extremely useful at times.

The *straight elevator* is inserted between the tooth to be extracted and its neighbour, and the flat blade is pushed between the tooth and alveolar margin as far as possible. The handle is then depressed, which tends to elevate the tooth. It often requires several of these

movements before the tooth is loosened. The tooth should be held firmly with the thumb and forefinger during the operation, to prevent its accidentally slipping down the throat. When the tooth is loosened lower forceps are used to remove it.

The *curved elevator* is used to remove broken roots. Pass the elevator into the empty socket and elevate the root by forcing the point of the elevator through the septum of bone.

CONTINUED HÆMORRHAGE AFTER EXTRACTION OF TEETH

Severe or continued hæmorrhage after tooth extraction is a common emergency. In such cases one rightly suspects, and endeavours to elicit, the history of a hæmorrhagic diathesis, but in the majority of instances the continued hæmorrhage is not due to hæmophilia. Within the tooth socket there is an open vessel which, in more accessible situations, would have warranted ligature in the first instance. Furthermore, it is probable that the bony alveolus has been fractured, and occasionally there is a piece of bone loose in the socket. The latter helps to prevent the contracture of the wound, and may be the cause of the continued bleeding.

We will assume that mouth-washes, local applications of various kinds such as adrenalin, and packing with strip gauze soaked in hydrogen peroxide or other hæmostatic preparations have failed to arrest the hæmorrhage. Take two pairs of dissecting forceps and a quantity of small gauze pledgets. Open the mouth widely with a mouth-gag and instruct the patient to keep his tongue still. Gently mop away the blood and blood-clot from the socket with one pair of forceps and with the other turn back the mucoperiosteum. Ascertain if there is a loose fragment of bone which can be removed.

Demonstrate the location of the bleeding vessel. Pick up a pledget of gauze in one forceps and with it apply lateral pressure to the soft tissues of the socket. With gauze in the other forceps mop the cavity dry. Proceed in the same way, applying pressure on the other side of the socket. Usually it can be demonstrated that pressure on one or other lateral wall stops the hæmorrhage.

If a piece of bone has been removed, all that may be necessary is to continue pressure here for a few moments and then to improvise a method for keeping up this pressure. For instance, a small roll of gauze may be inserted, and upon this the patient closes his jaws and a four-tailed bandage keeps the parts at rest. At other times, when the bleeding is from the lingual side, a mop of gauze is tied on the end of a blunt object, such as the handle of an aneurysm needle, and the patient himself keeps up this pressure for half an hour.

If these measures fail, or it is judged that they are unlikely to succeed, there is the choice of two methods of securing hæmostasis.

1. *Suture of the Gums.*—Novocain infiltration may be used, but generally the patient, exhausted by many attempts to stop the hæmorrhage, is apprehensive of the injection, and general anæsthesia is to be preferred. Using a fine, curved needle on a holder a catgut mattress suture is passed as shown in *Fig.* 520 and tied. The loop should be on the side from which the bleeding has been demonstrated to occur, the knot falling on the opposite side.

2. *The 'Cork Stopper'.*— The first time I used this method was in the case of a medical student whose gum had been bleeding for forty-eight hours, and every form of more usual treatment, with the exception of gum suture, had been employed unsuccessfully.
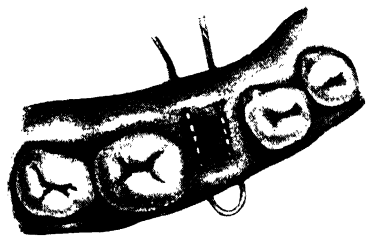
Fig. 520.—Bleeding from a tooth so Method of suturing the gums.

A good cork is selected from the dispensary, and with large scissors one fashions a blunt wedge ▼ which, it is judged, will fit the space between the two teeth. The cork is then sterilized by boiling. A piece of gauze soaked in hydrogen peroxide is laid across the socket, and the cork, after further trimming and fitting by the method of trial, is wedged between the two teeth (*Fig.* 521). The patient closes his jaws upon the stopper, and a four-tailed bandage completes the procedure. After about twelve hours the cork and dressing are removed. The five occasions in which I used this method have proved highly satisfactory. All were cases of severe hæmorrhage and other means had failed. It is obvious that the method is somewhat limited in its application, for there must be a sound, or at least substantial, tooth on either side of the bleeding socket.

Bleeding Due to Hæmophilia.— I have treated three male patients, aged 30, 24, and 21 respectively, with a well-marked history of hæmophilia, admitted after tooth extraction because of continued hæmor-
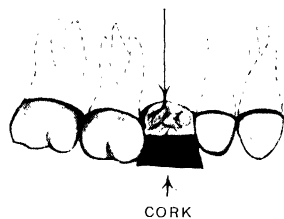
CORK

Fig. 521.—The cork-stopper method of controlling persistent hæmorrhage from a bleeding tooth

rhage. All have been dealt with in the same way. Twenty c.c. of alien blood have been injected into the rectus sheath. In one case this was combined with the 'cork stopper' described above. In each case the hæmorrhage ceased within a few hours.

Hæmophilia is more fully discussed on p. 685.

Renewed Hæmorrhage.—Very rarely hæmorrhage recommences after all the foregoing efforts to check it permanently. Blood transfusion will be indicated, if it has not become necessary before this time. The coagulation time of the blood should be taken as a matter of routine in all cases of persistent bleeding, and, if it is prolonged, blood transfusion may be expected to supply the deficient prothrombin.

In dealing with cases of persistent bleeding one should realize that ligature of the external carotid artery is futile. In the case of the upper jaw (usually the seat of the troublesome complication) Silverman recommends, and has practised successfully on five occasions, ligature of the posterior palatine artery. The vessel must be exposed
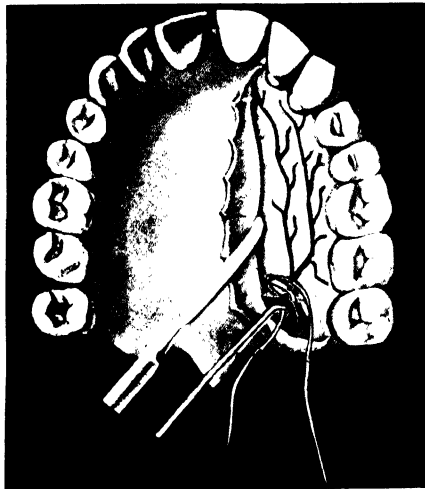
ligature of the posterior palatine artery. (*After Silverman.*)

at its exit from the posterior palatine foramen. This is accomplished by lifting up the mucoperiosteum from the bone with a periosteal elevator, using the knife as little as possible. The vessels are easily identified as they emerge from the foramen, and they can be stretched sufficiently to insert a ligature beneath without fear of rupture (*Fig.* 522). Alternatively a boiled match-stalk could be driven into the posterior palatine foramen, but ligature is to be preferred. The flap is not sewn, but held roughly in position by a swab on a holder until a temporary dental plate can be made to keep it in position.

WOUNDS OF THE TONGUE

The commonest wound of the tongue is caused by the patient himself biting the organ in an epileptic seizure, or as a result of a blow on the chin.

In the anterior two-thirds hæmorrhage is readily arrested by pinching the tongue between finger and thumb behind the laceration ; since the organ is slippery, a piece of cloth or gauze is employed in order to maintain a good hold. Wounds in this situation present no overwhelming difficulty.

As a means of checking severe hæmorrhage in the posterior part of the tongue, Heath recommends passing the finger as far back as possible and hooking the tongue forward on to the jaw. In severe wounds deeply placed it is best to perform laryngotomy under local anæsthesia. After plugging the pharynx and anæsthetizing the patient via the laryngotomy opening the tongue may be properly repaired with deep sutures which will at the same time control hæmorrhage.

" Even if the segment be almost completely separated, so that it is attached by nothing more than a thread of muscular or mucous tissue, it should be sutured to the stump in the hope, which is not in vain, of preserving it " (Butlin).

Wounds of the tongue heal readily, though swelling and inflammation are present in the early stages.

ACUTE GLOSSITIS

Acute glossitis is a rare condition. I have been called to treat but two cases with urgent symptoms. They are both instructive, and I will briefly refer to them.

Case 1.—Mrs. W., aged 70, had Ludwig's angina, and was treated as described on p. 543 by ' decompressing the mylohyoid ', under which two drachms of pus was found. Next morning she was much better. That evening I was hastily summoned, for her tongue had become so large in the space of half an hour that it protruded considerably from the mouth, and the house surgeon considered that tracheotomy would be necessary. The patient was salivating profusely, but it was found that when she lay on her side and a piece of gauze was tucked into the dependent corner of her mouth, the saliva ran away and this lessened the feeling of impending suffocation. The tongue was coated with paraffin, antistreptococcal serum was administered, she was fed with a nasal tube, and in forty-eight hours her tongue had receded within the mouth.

Case 2.—A girl, aged 10, was brought to hospital with her tongue protruding fully 1½ in. from her

Fig. 523. Incisions for the relief of very acute glossitis.

mouth. Her mother stated that the trouble began two days previously, and that she had had a similar attack three years before. The temperature was 102° and the pulse 130. There was a herpetiform eruption on the tip of the tongue and some membrane not unlike diphtheritic membrane under the tongue. The submaxillary glands on both sides were enlarged and tender. A piece of the membrane was removed and sent for bacteriological examination, and the unexpected report was returned—'Vincent's spirillum'. Treatment was undertaken by painting the tongue with N.A.B. solution. Within three days the condition had cleared up.

This limited experience shows that success may attend expectant treatment. If the symptoms continue, or acute glossitis is particularly severe, the tongue should be incised. Referring to a case of acute glossitis, Sir Henry Butlin wrote, "Mr. Wormald then took a knife from his house surgeon, and, to my horror, cut deeply into the substance of the tongue on each side of the middle line for a length of at least two inches. The operation appeared to me at the time most brutal, but on the following day I found that the man's symptoms were marvellously relieved." The incision should be made with a sharp curved bistoury to the depth of one-third of an inch on either side of the middle line, as shown in *Fig.* 523. The incisions performed in this way give rise to only moderate bleeding, which is beneficial.

In a case of a deep abscess of the tongue with acute symptoms, I thrust a pair of sinus forceps into the abscess cavity from the under surface of the tongue. The method proved satisfactory.

FRACTURE OF THE NASAL BONES

Compound Fracture.—

An overhead tramway cable snapped and hit a woman in the face. She was admitted in a shocked condition with an extensive wound over the bridge of the nose. At operation, after the wound had been excised, it was found that both nasal bones had been driven backwards. By inserting a hæmostat first up one nasal cavity and then the other, each bone was elevated into position. A quarter-inch rubber tube was passed up each nostril, and

Fig. 524. Compound depressed fracture of the nasal bones. The bones have been elevated and kept in place by rubber tubing. The wound was afterwards excised, disinfected, and sutured.

these were fixed in position by a stitch trans fixing the tubes and the columella. The wound was then closed with the finest sutures. The end-result was pleasing.

Recent depressed fractures of the nasal bone should always be elevated. This can be readily accomplished by a

hæmostat, as was done in the above case. If there is a tendency for
the bones to fall back, rubber drainage tube passed into each nostril
and fixed there (*Fig.* 524) for three days will act as an efficient
splint.

In cases uncomplicated by a wound, the elevation of the fractured
bone can usually be maintained without a splint by the patient finger-
ing the bridge of the nose at frequent intervals for a week. Rushton
Parker states that by this means the bridge can be moulded to any
shape desired.

SEVERE EPISTAXIS

A man of 40 had his nasal septum removed by operation three
days previously. Bleeding had continued most of the night in spite of
nasal plugging and hæmostatic serum. The blanched patient vomited two
pints of blood and clots whilst being examined. His general condition was
grave. He was taken to the theatre, and after the plugging had been removed
blood poured from the right nostril. A gum-elastic catheter was passed
down the right nostril. By this means the posterior nares were plugged.

Fig. 525. --A penile clamp being used, in conjunction with other methods, to
arrest severe bleeding from the front of the nose.

Both anterior nares were plugged with gauze soaked in hydrogen peroxide.
A square of gauze was then laid over the nose and a penile clamp was applied
(*Fig.* 525). The hæmorrhage was now well under control. Three hours
later the penile clamp was removed as it was a source of discomfort. As
soon as arrangements could be made blood transfusion was carried out, with
great benefit to the patient. All plugs were removed in thirty-six hours
and no further hæmorrhage occurred.

In a case of idiopathic epistaxis of average severity, first take a
reading of the blood-pressure. If arterial tension is abnormally high,
probably the bleeding from the nose is saving the patient from

impending death from apoplexy, and it should be allowed to continue. Venesection may be indicated in such a case. When the blood-pressure is normal or subnormal, hæmorrhage must be controlled.

Plugging the Anterior Nares. Packing the nose on the affected side with strip gauze soaked in hydrogen peroxide or adrenalin
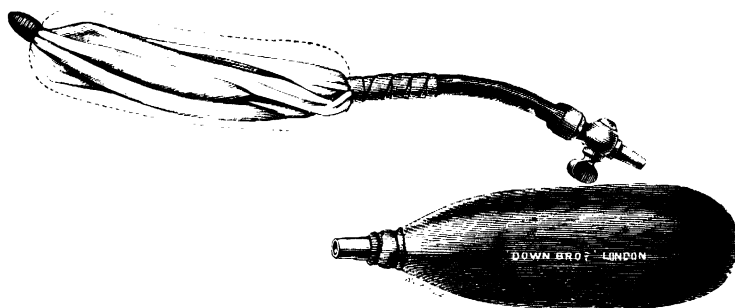
Fig. 526. Cooper Rc

solution is the method generally employed. Cooper Rose's inflating plug (*Fig.* 526) is convenient and useful if the apparatus is at hand.

Serious epistaxis must be controlled by plugging the posterior as well as the anterior nares.
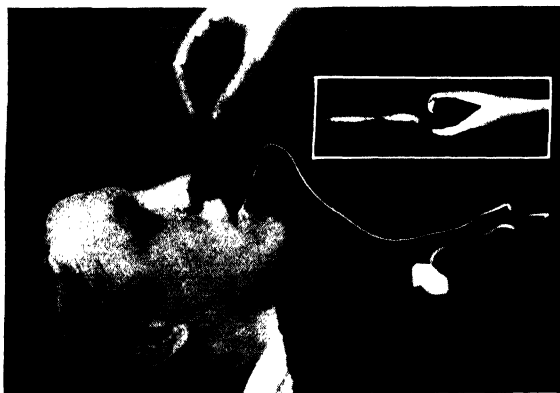
Fig. 527. Plugging the posterior nares. *Inset.* Method of perforating the tip of the gum-elastic catheter with a towel clip prior to passing the silk thread.

Plugging the Posterior Nares. It is not necessary to have a special instrument. A gum-elastic catheter is passed down the nostril and recovered in the pharynx, its point being brought out of the mouth (*Fig.* 527). With a towel clip a hole is punctured in the eye

of the catheter. Through this hole is passed a needle carrying a
length of silk to which a small roll of gauze is attached. The silk is
firmly tied to the catheter. The catheter is withdrawn, pulling the
silk after it, and the plug comes to rest in the nasopharynx, where it
is manipulated to lie nicely over the posterior nares. The silk is
drawn fairly taut and fixed to the forehead with adhesive plaster.

Foreign Bodies in the Nose. *See* p. 699.

Acute Suppuration in Nasal Accessory Sinuses.—*See* p. 701.

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CHAPTER XXXII

THE NECK

TRACHEOTOMY

At one stage of my career it was my duty to supervise the operation of tracheotomy performed by the house physician in charge. This experience gave me ample opportunity of seeing that tracheotomy in a small child is by no means a trivial matter. The classical operation then taught and performed left much to be desired in the matter of exposure, and only too often the operator became embarrassed by hæmorrhage. Perhaps the most constant source of trouble was to be seen in the use of the tracheal dilator. The jaws of this instrument open when the handles are approximated (*Fig.* 528)—that is, their action is precisely opposite to that of all hinged surgical instruments in common use, notably hæmostats and scissors. In the heat of the moment this reversed principle caused much confusion, a sufficient reason for recommending that the tracheal dilator be entirely discarded.

Except in those rare and desperately urgent cases where the operator is single-handed, Digby's method of performing tracheotomy should be employed. By mastering Digby's technique we have at our command a universal method—high and low tracheotomy are no longer distinct operations. Digby's operation will therefore be considered in detail.

The two emergency measures to be considered in dyspnœa due to obstruction are tracheotomy and laryngotomy (*Fig.* 529)—tracheotomy for children, laryngotomy for adults.

Fig. 528. Usual type tracheal dilator.

Details of Performing the Operation of Tracheotomy. —

Anæsthesia.— In young children (who form the bulk of these cases) local anæsthesia is unsatisfactory, and a little chloroform is administered. For older children and adults local anæsthesia is advised, and will be found to be eminently satisfactory. Novocain is injected into the skin and subcutaneous tissue of the middle line

of the neck, from the lower border of the thyroid cartilage downwards
to about the middle of the thyroid isthmus.

Position of the Patient.—A child should be pinned in a blanket
and covered by a mackin-
tosh sheet. A well-pinned
blanket serves to restrain
the arms. Place the patient
close to the right edge of
the table ; this is of es-
pecial importance in the
case of a little child.
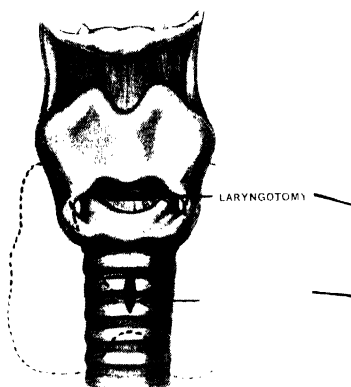
Fig. 529.   Emergency openings into the windpipe.

Fig. 530.—
Tracheotomy.
The assistant,
standing on the
patient's left,
places his right
hand on the fore-
head, and his left
on the occiput.
He then fully ex-
tends the neck,
and holds the
head firmly in this
position until the
tracheotomy tube
is safely *in situ.*

A small sandbag or rolled-up towel is insinuated beneath the shoulder. To an assistant should be relegated the sole duty of keeping the patient in the correct position. This he does by standing on the patient's left. After fully extending the head he holds it firmly in the manner shown in *Fig.* 530. It is of the utmost importance that the assistant should maintain this position and at the same time see that the chin and sternal notch are in the same straight line.

Once the patient is in the correct position the operator locates the cricoid cartilage and takes all his bearings from this point.

Digby's Technique.—Exactly in the middle line an incision is made from the *upper* border of the cricoid, downwards for one and a half inches. The deep fascia

Fig. 531.—After making a transverse incision through the fascia below the cricoid the point of a haemostat is inserted behind the isthmus of the thyroid gland.

is divided vertically in the length of the incision, and the cricoid is exposed.
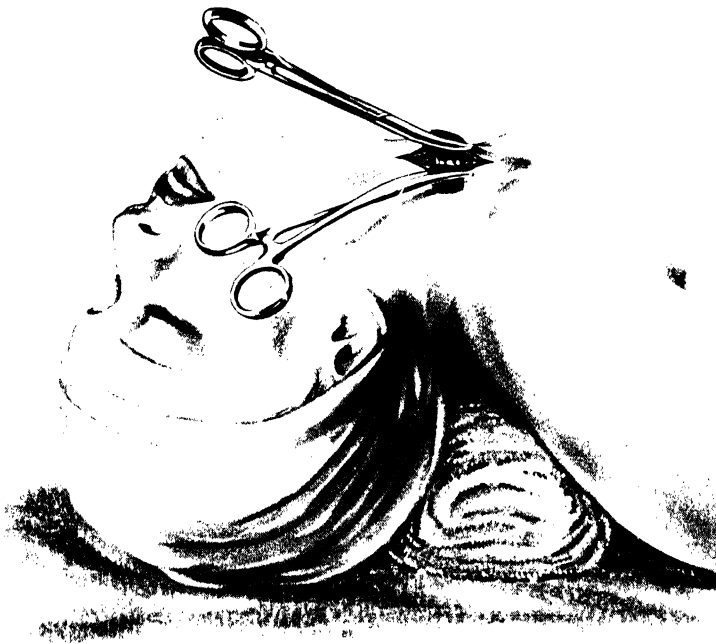
Fig. 532.—Utilizing the tunnel formed by the method illustrated in Fig. 531, the isthmus of the thyroid is divided between haemostats and the trachea exposed.

The fascia attached to the lower border of the cricoid is incised *transversely* and the commencement of the trachea is in view. The point of a closed hæmostat is passed downwards, close to the trachea and behind the isthmus of the thyroid (*Fig.* 531). Slightly opening and closing the hæmostat may assist its passage. The tissue thus raised is clamped close to the middle line by one hæmostat and then by a second placed parallel to the first. The tissue between the hæmostats is divided (*Fig.* 532), and the hæmostats are rotated laterally through 90°, the handles being slightly depressed so as to raise the points. This rotation usually peels off the tissues sufficiently to expose
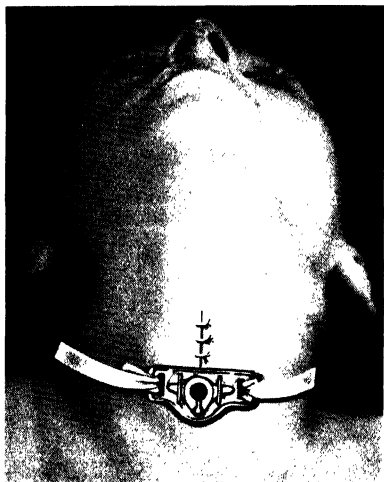
the trachea, but a touch of the scalpel on each side may be necessary. The first four rings of the trachea are now exposed with the utmost clearness. A vertical incision is made through the second, third, and fourth rings, not as a stab, but as a gentle incision with the knife held in pen-holder fashion, the little finger resting upon the upper border of the manubrium. Seizing one edge of the tracheal wound with dissecting forceps, snip off a small portion of one or two rings with scissors. Do the same on the other side so as to form an oval window in front of the trachea. This is much better than thrusting the tracheotomy tube through a mere slit. It at once relieves dyspnœa and allows the thyroid isthmus, already clamped, to be ligatured. The tracheotomy tube is inserted, the pilot removed, and the tube is secured by the tapes (*Fig.* 533). The skin is approximated about the tube, and it is only after this is completed that the assistant releases his grasp of the patient's head.

Tranquil Tracheotomy (Sir St Clair Thomson).—The commotion which attends the first entry of air into the trachea can be avoided by the intratracheal injection of cocaine. A hypodermic syringe is charged with 20 min. of a 2½ per cent solution of cocaine in the case of an adult and 5 min. of 1 per cent solution in the case of a child. As soon as the tracheal rings are laid bare the syringe is grasped as one does a pen, with the forefinger about an inch from the extremity of the needle. The middle, ring, and little fingers rest on the neck, and they prevent the point from penetrating more than a

quarter of an inch within the lumen of the trachea. The cocaine
solution is injected into the cavity of the windpipe (*Fig.* 534), and
the needle is withdrawn sharply. The liquid in the trachea at once
gives rise to a slight cough, but it causes no distress. If there is no
great urgency, as much as ten minutes should elapse for the cocaine
to take its full effect. At the end of that time the incision into
the trachea can be made, and the tracheotomy tube is introduced
without spasm or even the slightest cough. "The calm with which
this procedure takes place is in striking contrast with the agitated,
hurried, and often bloody and dangerous operation of former days"
(Sir St Clair Thomson).
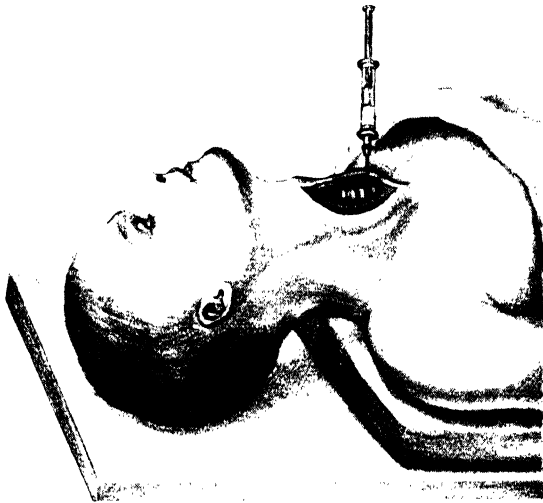
Fig. 534. Tranquil tracheotomy by injecting a solution of cocaine into the lumen
of the trachea. (*After Sir St Clair Thomson.*)

Tracheotomy in Desperately Urgent Cases (Stabbing the Trachea).—
The head is held by a nurse or other assistant in the extended posi-
tion exactly in the middle line. The cricoid is palpated, and the finger
and thumb of the left hand mark this point, at the same time making
the skin in the neighbourhood tense. Using a rather narrow-bladed
knife a skin incision is made downwards for three inches. Under the
cricoid a sharp hook is inserted and with its aid the larynx is lifted
up and steadied by the left hand. The scalpel in the right hand is
held so that its cutting edge is directed towards the patient's chin.
With a smart stab the blade enters the trachea about half an inch
below the cricoid. The stab-wound is extended upwards a trifle, and
the knife is twisted sufficiently to allow the asphyxiated patient to

get air through the wound. At this stage we pause for a moment,
and handing the hook to the assistant to hold, pick up a short hæmo-
stat. The point of the hæmostat is guided along the knife-blade into
the trachea. The blades of the hæmostat are opened, the knife is
withdrawn, and the tracheotomy tube inserted. Only then is the
sharp hook removed.

This measure can be carried out very rapidly, and I have used
it on several occasions with the greatest satisfaction.

LARYNGOTOMY*

As a temporary means of relieving sudden laryngeal stenosis *in
adults* laryngotomy is unsurpassed. It is performed very easily, free
from danger, and the wound will heal readily. It should not be
employed in children.

H. H., aged 19, had a sore throat for twenty-four hours. He gargled
with vinegar, but went to work. At 8 p.m. he had difficulty in breathing
and called in his doctor, who, finding the patient cyanosed, sent him to
hospital. With a laryngeal mirror it was possible to see the œdematous
glottis, which presented an appearance very like a normal cervix uteri.
The throat was sprayed with cocaine, and he was ordered inhalations of
tinct. benzoini, with some benefit. At 3 a.m. I was summoned to find the
patient cyanosed, sweating, and fighting for breath. Laryngotomy was
performed. Recovery.

Technique.— The patient's head is extended and held in the mid-
line.

1. A vertical fold of skin is pinched up so that the centre of it is
at the level of the upper border of the cricoid cartilage when the head
is extended.

2. The centre of the uplifted skin is then transfixed and cut
through so as to make a transverse incision one inch in length.

3. A pair of pointed scissors (such as Mayo's) curved on the flat
is plunged through the cricothyroid membrane (*see Fig.* 529) down-
wards and backwards close to the upper border of the cricoid so as
to avoid the small transverse artery.
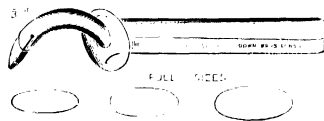
Fig. 535 —Butlin's laryngotomy tube with pilot. Sir Henry Butlin usually
employed the largest size.

4. The laryngotomy tube (*Fig.* 535) is inserted between the blades
of the widely opened scissors.

* As an alternative an intratracheal catheter can be passed if the apparatus
is available and the surgeon is skilled in its use.

Any bleeding is checked by the insertion of the tube. In cases of desperate urgency a knife held short can be plunged through the cricothyroid membrane. The knife is held in the opening with a slight twist until a closed safety-pin, or some such object, is available.

EXPOSURE OF THE GREAT VESSELS OF THE NECK

Wounds of the neck involving the great vessels call for adequate exposure. The classical incision for ligature of these vessels fails to provide this exposure. As a consequence many patients have been lost because the surgeon, surprised by a sudden gush of blood, has only been able to apply haphazardly some hæmostats at the bottom of a small incision.

Exposure of the Common Carotid Artery.—A pillow is placed under the shoulders, and the head is turned strongly to the opposite side. The incision is shown in *Fig.* 536—inset. It follows the anterior border of the sternomastoid to the manubrium, then outwards along the upper border of the clavicle to its middle. When the middle of the clavicle is reached the external jugular is seen : it is not necessary to touch this vessel. The platysma and fascia are
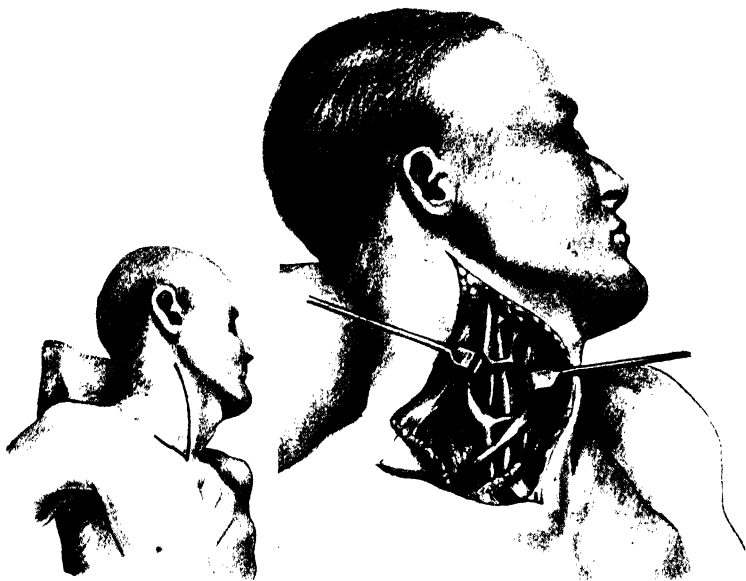
Fig. 536.—Exposure of the common carotid artery.   (*After Fiolle and Delmas.*)

divided. It is convenient to cut down on to the anterior edge of the sternomastoid in the ascending limb of the incision. Having turned back the skin-flap, insinuate the finger beneath the tendinous sternal head of the sternomastoid and divide it an inch above the clavicle. Proceed in the same way to deal with the clavicular head. The sternomastoid can now be retracted in the same manner as the skin-flap (*Fig.* 536). The omohyoid will be seen crossing the underlying space. It is not necessary to divide this muscle, because it can be readily drawn upwards or downwards as desired. Under the omohyoid covered by fascia will lie the great vessels of the neck clearly exposed to view. The common carotid, its bifurcation, and the internal and the external carotids will be seen, covered partially by the veins which drain into the internal jugular. The common carotid artery can now be tied if necessary.

Reconstruction of the Region.—The sternal and clavicular heads are sutured to their respective stumps. The stitches should be of the mattress type, and include the superficial fascia. Should drainage be necessary, a piece of corrugated rubber is inserted at the lower edge of the wound. The skin incision is closed.

Fig. 537. Drawing to illustrate method of ligature of external carotid artery. (*Norman Patterson—by kind permission of the 'Lancet'.*)

Ligature of the External Carotid Artery.

In order to ligate the external carotid artery for some condition other than a wound of the neck—for instance, haemorrhage occurring from the tongue—it is unnecessary to divide the sternomastoid unless one is hampered for room, as is the case when the patient has a short, fat neck ; another indication for extending the exposure would be if enlarged lymphatic glands were found obscuring the view. Under ordinary conditions an ample incision along the anterior border of the sternomastoid with suitable retraction enables the carotid to be located by its pulsations. The carotid sheath is exposed and incised over the jugular vein, which is freed from its fascial covering for a length of from two to three inches into the neighbourhood corresponding to the region of the bifurcation. The vein is now carefully separated from underlying structures, including the vagus nerve. The jugular vein is then retracted medially (*Fig.* 537)—not laterally as in the classical operation—until the

bifurcation of the common carotid comes into view (Norman Patterson). The hypoglossal nerve tends to be retracted forwards with the vein and may never come into sight ; of course, care must be taken to avoid damaging this nerve, or its branch the descendens hypoglossi. The carotid is followed up to its bifurcation. It is essential to remember the peculiar anatomy of the region, viz., that the external carotid lies at first on the inner side, then behind, and then on the outer side of, the internal carotid. Using a Watson Cheyne's dissector, the fascia is freed around the junction. That it is the external carotid artery is at once apparent at this stage, for arterial branches spring from the trunk, and this trunk only. Keeping very close to the artery, the better to avoid the superior laryngeal nerve, an empty blunt aneurysm needle is passed from without inwards. Kangaroo tendon is a good material to use for the ligature, but silk or strong catgut may be employed.

Complete Exposure of the Internal and External Carotid Arteries, together with the Internal Jugular Vein. —The indications for mobilizing the upper part of the sternomastoid are as follows :

1. Wounds of the upper part of the neck when a lesion of the great vessels is suspected.

2. Hæmorrhage from the internal jugular vein near its bulb, as sometimes occurs after operations for the removal of cervical glands.

3. When it is desired to ligate the external carotid artery, but access is difficult owing to the presence of fat or enlarged glands.

Prolong the incision over the mastoid process (*Fig.* 538 inset). Clear the tip of the mastoid process and observe the origin of the sternomastoid muscle. With a Gigli's saw, or a chisel and mallet, remove the extreme tip of the mastoid process. If a Gigli's saw is used, keep strictly to the bone on the under surface when passing the saw. The tip of the mastoid having been removed, turn it back, with all the muscle inserted into it (*Fig.* 538). Under the sternomastoid will be found the posterior belly of the digastric. This is isolated completely, hooked up on the finger, and divided straight across about its middle. The divided ends of the muscle belly are turned respectively upwards and downwards. The internal carotid artery, the external carotid artery and its branches, and the internal jugular vein right up to the bulb, are beautifully displayed.

Reconstruction. The divided digastric muscle is sutured. The tip of the mastoid is fixed in place by a few sutures uniting the periosteum and fibrous tissue. According to circumstances, the integument will be closed completely or provision made for drainage.

Ligation of the Internal Jugular Vein. —On many occasions I have ligatured the internal jugular vein through a comparatively

small transverse incision opposite the middle of the anterior border of the sternomastoid. As soon as this muscle is seen it is retracted backwards. There is seldom any difficulty in locating the large venous trunk. If there is, the wound must be extended somewhat. Difficulty in finding the vessel usually means that it is thrombosed.

Fig. 538.—Complete exposure of the carotid arteries and the internal jugular vein. (*After Fiolle and Delmas.*)

The operation is undertaken to prevent spread of infection from an infected lateral sinus. A thrombosed jugular must be followed downwards and if possible ligated below the thrombosis.

Hæmorrhage from the Internal Jugular Vein at its Exit from the Skull.—It has been indicated that detachment of the tip of the mastoid process gives good exposure of the internal jugular vein almost

to the base of the skull. On infrequent occasions even this exposure is insufficient to control hæmorrhage from the bulb of the jugular. The only hope then is to trephine rapidly over the lateral sinus behind the mastoid process. By inserting packing between the dura and the bone over the sinus, the blood-stream along the channel is dammed.

LIGATURE OF THE LINGUAL ARTERY

In urgent surgery ligature of the lingual artery is rarely indicated. On one occasion ligature of both lingual arteries, which under the circumstances was the only procedure possible, served me well :—

I was called to see H. S., aged 62, who had had diathermy excision of a carcinoma of the right side of the floor of the mouth. He had been bleeding intermittently for three days. The right external carotid artery had been tied forty-eight hours previously, but hæmorrhage continued. Blood was streaming from his mouth, and he was blanched. Both lingual arteries were tied by the classical method. The hæmorrhage ceased forthwith. The patient recovered and returned home.

Position of the Patient. The head is extended and turned to the opposite side. The anæsthetist is requested to keep the head well up and the lower jaw fixed. The incision is shown in *Fig.* 539. It is made from a little below the angle of the jaw to below the symphysis menti, convex downwards. Its centre is just above the great cornu of the hyoid bone. The incision is deepened through the platysma and fascia until the submaxillary gland is dislocated from its bed and retracted upwards over the margin of the jaw. The tendon of the digastric muscle and its two muscle bellies are now defined. A blunt hook is passed round the tendon, which is drawn downwards and towards the surface, a very important step in the operation. The

hyoid bone, carrying with it the hyoglossus muscle, can now be made out. Crossing the hyoglossus muscle are the hypoglossal nerve and the ranine vein. A director is passed under the hyoglossus muscle, which is divided on to the director near its insertion on the hyoid

HYPOGLOSSAL NERVE

RANINE VEIN

LINGUAL ARTERY

Fig. 540. Ligature of the lingual artery. The submaxillary gland has been retracted upwards and the artery exposed by dividing the hyoglossus muscle.

bone. Beneath the hyoglossus will be found the lingual artery (*Fig.* 540), which is divided between ligatures. It is not necessary to suture the hyoglossus muscle. The submaxillary gland is allowed to fall back, and the wound is sutured.

CUT THROAT

In more than half the cases of cut throat which reach surgical aid the wound does not involve any vital structure that is, the skin, platysma, and perhaps the sterno-mastoid or other muscles are sever-ed. Even the external jugular vein does not often come under the category of a vital structure in this respect. The treatment of this superficial variety follows element-ary surgical principles. The wound edges are cleansed and trimmed, the vessels are ligatured, the muscles are stitched together with catgut, and the wound is closed, usually without drainage.

Of the deep wounds of the throat much more must be said.

ABOVE HYOID (8)

(17)

(18)

CRICOID (10)

TRACHEA (4)
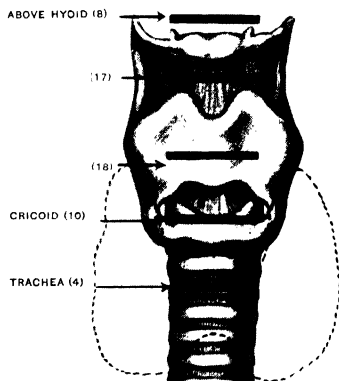
Fig. 541.— Position of the wound into the air-passages of 57 cases of suicidal cut throat with a deep wound.

They may be divided into certain categories according to position (*Fig.* 541).

Wounds above the Hyoid Bone.—The wound, when self-inflicted by the right hand, is usually deeper on the left. After cleaning up the area, explore the wound with a finger. It will sometimes lead into the mouth. If this is the case, as soon as spurting vessels have been clamped (the facial artery usually requires attention), examine the epiglottis. The epiglottis is quite often partially cut through near its base; it is rarely completely divided. Sew the divided epiglottis with catgut—the stitches hold fairly well. The mucosa of the pharynx is trimmed up with scissors and united. If the submaxillary gland is badly lacerated, it is best removed. Once the pharynx is closed and spurting vessels are ligatured, the whole cavity is mopped out with tincture of iodine and swabbed dry. The muscles are then sewn together in appropriate layers and the wound is closed, with drainage.

Wounds of the Thyrohyoid Membrane.—Again the wound is explored with the finger. An opening through the thyrohyoid membrane is a common operative finding after self-inflicted incised wounds of the throat. The epiglottis is found partially divided in nearly half the cases. In one example the notes of which I possess, the top of the epiglottis was almost completely severed, and this fragment of over an inch was removed without harmful effect. As a rule every effort should be made to repair the epiglottis. If the side wall of the pharynx has been opened, it must be carefully united. The severed thyrohyoid membrane then receives attention; the wound should be trimmed and sutured. If the wound is a small one, and after it has been closed there is no respiratory distress, it is unnecessary to make an artificial airway. In the majority of instances, however, laryngotomy is advised.

It is important to note that it is the simple operation of *laryngotomy* which is recommended. The examination of notes of a large number of cases has shown me that the dark, dangerous, and bloody operation of low tracheotomy is often (quite unnecessarily) performed in this and the next variety of cut throat. If respiratory distress is marked at the commencement of the operation, laryngotomy should be performed forthwith before attention is directed to the wound.

Wounds of the Thyroid Cartilage.—An incised wound of the thyroid cartilage is fairly easily repaired, but a stitch through cartilage tends to cut out. If only reasonable tension is applied, and especially if a mattress suture can be inserted (*Fig.* 542), the thyroid cartilage is readily united. In most cases it is advisable to perform laryngotomy.

Occasionally there is loss of substance of the larynx, a triangular piece having been removed. Having detached one end of a pre-tracheal muscle, it is usually possible to swing this over and suture it into place in such a way as to form a patch. Exceptionally, the front wall of the larynx has been cut out, and there remains only the prospect of a permanent tracheotomy. Such cases, fortunately, usually succumb.
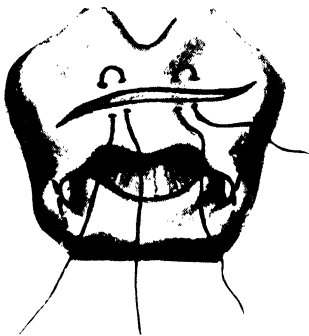
Fig. 542.—Suturing the cartilage.

Wounds above, below, or through the Cricoid Cartilage.—The correct treatment is to trim up and enlarge the wound if necessary. When the opening has been clearly defined, insert a laryngotomy tube and approximate the tissues around this.

Wounds of the Trachea. It is important to get good exposure. Divide the thyroid isthmus between clamps, after the manner of Digby (p. 519). When the opening has been made, a good-sized tracheotomy tube may be inserted through it. An alternative method which will be found convenient in certain circumstances is to perform tracheotomy below the wound and then proceed to repair the latter with sutures.

Wounds of the normal thyroid gland are readily deep sutures, a procedure which soon quells the somewhat hæmorrhage.

Complications after Cut Throat. Br and most lethal complication, and is definitely more frequent after the pharynx has been opened. A dose of intravenous mercurochrome in suitable cases might help to prevent this sequel.

Suppuration is, of course, prone to follow any incised wound caused by a non-sterile implement; nevertheless in this instance suppuration is curiously not much in evidence, unless the pharynx has been opened. A rubber drainage tube down to the site of the repair of the pharynx should always be provided.

Œsophageal fistula followed one case of which I have notes. It healed slowly.

A question which crosses our mind is whether suicidal cut throat is a condition upon which it is worth while expending much trouble. It is not the surgeon's province to adjudicate; it is his to do his best to repair the damage. Sometimes with the healing of the wound the patient is thankful.

THE NECK

WOUNDS OF THE THORACIC DUCT

Wounds of the thoracic duct are very rare, and those recorded have been incurred during an operation on the left side of the neck. The injury may be noticed at the time of the operation, or later, when chylorrhœa develops. It is doubtful if division of the duct, or alternatively its ligation, is necessarily fatal or even permanently injurious to health. No doubt this is accounted for by the multiple communications between the main duct and the venous system. In at least 50 per cent of cases the main outlet of the thoracic duct is duplicated, which helps us to appreciate why division or ligature of what is presumably a vital structure may be of no consequence.

If the injury to the duct is recognized at the time of the accident the duct may be implanted into a vein, as was done in the following interesting case :—

During an operation for dissection of cervical glands Edward Harrison, of Hull, noticed milky fluid collecting in the wound. The fluid was mopped up. After the dissection was complete the fluid collected again, and Harrison then detected that it was coming from a divided end of a vessel about the size of a small straw. Close by the divided thoracic duct was the external jugular vein, which had been previously cut and ligatured. After a small clamp had been applied to the vein and the ligature removed, the end of the thoracic duct was implanted into the mouth of the vein in the following manner. Using three of the finest intestinal needles, sutures were passed through the opening in the vein and each needle then caught up the duct about half an inch from its open end (*Fig.* 543). Care was taken that there was no twisting of the duct when it was implanted. The vein was then held open by the three sutures, and with fine forceps the operator pushed the divided end of the duct into the open vein, holding it in position while the house surgeon tied the sutures. The space between two of the three sutures was greater than the other spaces : this was purposely made, as the size of the lumen of the two vessels was so different. This loose portion of vein was accordingly sutured. The clamp was then removed, and there was no leakage. Recovery.
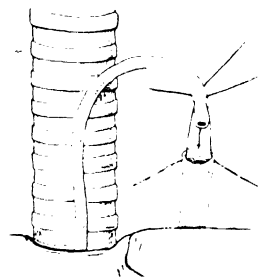
Fig. 543.— Method of suturing thoracic duct to the external jugular vein. (Harrison—by kind permission of the " British Journal of Surgery".)

When the accident is not recognized at the time, and chyle pours from the cervical wound, firm pressure by pad and bandage may be tried. When the chylorrhœa is not excessive this simple measure is effective. Should the leakage continue, it means that the main, and possibly the only, effective outlet of the thoracic duct has been severed. After the patient has had a feed of cream the wound must be reopened. Every effort must be made to effect an anastomosis between the severed thoracic duct and the venous system. A ligature of the

divided duct may act perfectly ; on the other hand, it may be followed by œdema of the head and neck, and other serious complications.

Bucknall's Case.—

The patient was 54, and weighed 16 stone. A mass of tuberculous glands was dissected from the left supraclavicular triangle. After operation chyle poured from the wound. Each day between two and three pints leaked away, the burly patient rapidly lost strength, and his general appearance caused grave anxiety. On the sixth day, as the discharge showed no signs of abating, operation was decided upon. He was given a pint of cream, and three hours later the wound was re-opened. There was no difficulty in finding the thoracic end, which was discharging the creamy fluid ; the distal end was soon located ; but it was found impracticable to unite them. Each was ligatured. After the operation the patient developed œdema of the head and neck, which may be attributed to the chyle passing through the right lymphatic duct. A few months later he died of miliary tuberculosis. In some way the division or ligature of the duct may have distributed the disease.

I had a similar case following extirpation of malignant glands. After a feed of cream it was quite simple to locate the duct, but I found it difficult to ligate it even with the finest silk ; the ligature cut through. Finally a ligature appeared to hold well. Forty-eight hours later the chylorrhœa was as bad as ever. The wound was again opened and packed firmly with gauze soaked in flavine. Pressure was maintained for four days by a pad and a bandage passing under the opposite axilla. This acted admirably. The patient recovered and resumed his duties as a postman for a short time, only to succumb to secondaries in bones. The experience of the case showed me the futility of expecting a pad and bandage to control a leak in a concavity such as the supraclavicular triangle. The wound must be opened and the concavity filled with packing before exerting external pressure.

EMERGENCIES CONNECTED WITH THE THYROID GLAND

Hæmorrhage into a Thyro-adenoma.—If a patient with a goitre is suffocating, one assumes almost always correctly—that the goitre is the cause. Urgent dyspnœa may follow a sudden hæmorrhage into a cystadenoma of the thyroid. In the more severe forms death follows quickly unless surgical aid is forthcoming immediately. On being confronted with a case of impending suffocation due to a tense thyro-adenoma, do *not* at once attempt tracheotomy. To be of service the tracheotomy must perforce be a *low* tracheotomy (always a dangerous operation), the difficulties of which, on such an occasion, would prove almost insuperable. The immediate, the 'First-aid', treatment is to *divide the deep cervical fascia*, and thus allow the engorged thyroid tumour to bulge forward into the wound.

Aspiration of the cyst (*Fig.* 544) is an excellent form of immediate treatment. Aspiration of such a cyst causing impending death is described by E. M. Eberts :—

A farmer, aged 54, was admitted to Montreal General Hospital with an enlargement of the neck and dyspnœa. At 6 p.m. respirations became laboured and noisy. He was given an injection of morphia and atropine with considerable benefit. At 3 a.m. he became worse. There was marked cyanosis, cold sweat on the face and chest, and restlessness. The respirations were noisy, pulse 160. The patient rapidly relapsed into complete unconsciousness. An intratracheal catheter was introduced with immediate improvement. Oxygen was administered. At 3.30 a.m. the catheter became plugged with mucus. Insufflation apparatus was attached to the catheter and air and oxygen given for one hour, with slight improvement. At 4.30 a.m. a large aspirating needle was introduced into the swelling and 50 c.c. of thick, chocolate-coloured fluid withdrawn. This led to an immediate improvement, and in about five minutes the patient opened his

Fig. 544.

eyes and answered questions. At 5.30 a.m. the tracheal catheter was removed. By this time he had completely regained consciousness. At 10 a.m. the next day, after further aspiration, the cystadenoma was enucleated successfully.

If aspiration is not effective, or only partially so, as might be the case if a coagulum was present within the wall of the adenoma, then operation must be hurried forward. The pretracheal muscles must be divided, and the thyroid gland exposed. As the thyroid bulges into the wound an adenoma may be seen or felt, in which case it may be punctured by a small incision. If the breathing then becomes tranquil, enucleation of the wall of the cyst or adenoma, as the case may be, may be undertaken safely. Alternatively, in this contingency and those which follow immediately, intratracheal catheterization (if the apparatus for introducing it is available and the surgeon is skilled in its use) can be employed. Once the catheter is pushed

beyond the point of obstruction there is an adequate airway which
will serve, if necessary, for several hours.

Retrosternal Adenoma.—Should the adenoma be found to be mainly
retrosternal, aspiration is attempted under vision. If this reduces
the size of the swelling, and the circumstances are extenuating, the
advisability of evacuating the contents of the cyst only is to be
considered. More often the adenoma must be enucleated. Division
of the sternal heads of the sternomastoid aids considerably in the
matter of access. A blunt-nosed dessert-spoon can usually be pro-
cured, and this will help in delivery of the tumour ; it should be passed,
not in front of the goitre, but from the back and side. Having got
below the mass, the spoon is used to lever the goitre on to the surface.
Two stay sutures are also useful in helping lift the mass. Having
succeeded in delivering the retrosternal portion of the thyroid, pack-
ing is inserted into the space in which it lay. An incision is made over
the localized swelling, and as soon as the correct plane of cleavage
has been found, the adenoma is shelled out with the finger. Once

g. 545.   Deli ering a massive enlarge-
f the thyr id o
prevert death fron asp
covere l with a sali pad until arrangements
can be

the adenoma has been enucleated
there is very little trouble with
hæmorrhage, for all the vessels
come from above. Final hæmo-
stasis can be secured by a run-
ning suture which co-apts the
lips of the bed in the thyroid
gland proper in which the aden-
oma lay. Division of the man-
ubrium is so rarely required
that this step is not described.

**Goitre, other than a Simple
Cyst, causing Suffocation.**—More
rarely a definite localized aden-
oma cannot be found. If the
circumstances are extenuating,
and the operator is inexperienced
in this branch of surgery, the
following procedure may be
recommended. Having made a
collar incision, divided the pre-
tracheal muscles, and searched
for a localized swelling in vain,
deliver the offending lobe on
to the surface. This manœuvre
sometimes brings about restora-

tion of quiet respiration. If, on delivery, still no localized swelling

can be found, the immediate treatment may cease at this juncture.
The goitre may be left extruding from the wound (*Fig.* 545), and,
after under-running bleeding points with a ligature on a needle, the

Fig. 546. Adenomatous goitre showing compression of the trachea.
(*From De Quervain's 'Goitre', by kind permission of Bale, Sons & Danielsson.*)

mass is covered with a saline-soaked pad. The patient is returned to
bed until his condition has improved and arrangements can be made
for removal of the goitre.

Occasionally delivery of the offending lobe fails to improve the
breathing, or makes it
worse. These are cases in
which the trachea has been
compressed into the shape
of a sheath of a sword
(*Fig.* 546). We are now
faced with a difficult prob-
lem, and the following
method is suggested. Re-
turn the lobe which has
been delivered without
benefit. Perform laryn-
gotomy. Pass an intra-
tracheal, or other gum-
elastic catheter, through
the laryngotomy wound
downwards past the ob-
struction.
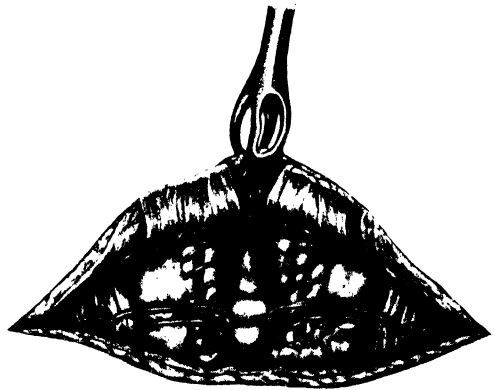
Fig. 547. Resection of the isthmus of the
thyroid. The sides of the trachea have been stitched
to the sternomastoid with the object of keeping a
patent airway.

For the exceptional case exceptional methods may be devised.
For instance, if the isthmus is reasonably small and not involved

in the pathological process, it is divided (*Fig.* 547). The retro-thyroid portion of the trachea is exposed. This will doubtless be found flattened from side to side. A stitch passed through each lateral wall of the trachea and anchored to the corresponding sterno-mastoid may help to give the trachea a tubular character once more.

Avoid performing tracheotomy if possible. Secondary infection of the wound will surely follow ; one of several serious complications which may be anticipated.

Less Urgent Cases of Dyspnœa caused by Goitre.—If a patient has dyspnœa and a thyroid swelling, it does not necessarily follow that the goitre is the cause of the trouble. De Quervain has seen mediastinal tumour, cardiac asthma, and Pott's disease with abscess cause dyspnœa in patients who happened to have a goitre. It behoves us to make a thorough examination of the case.

A good radiograph will often show the amount of displacement and deformity of the trachea. A radiograph taken in profile showing the trachea close up against the sternum suggests the probability of a cold abscess.

A full dose of morphia often decidedly alleviates the respiratory distress, and is a valuable pre-operative treatment. The possibility of introducing an intratracheal catheter should receive consideration. Successful intratracheal anæsthesia may permit a quiet, set operation.

If intratracheal anæsthesia is not practicable, a moment or so should be expended in getting the patient into the best possible posi-tion, for it will usually be found that if the head is tilted into this or that position, breathing is somewhat easier. Local anæsthesia may be used, but in the engorged condition of the neck and the restless state of the patient it will probably not be altogether satisfactory.

In the less urgent cases we have time to make arrangements for an operation which will follow the accepted methods of thyroid surgery. If urgent dyspnœa arises in the course of that operation, recourse is made to one of the procedures indicated already.

Post-operative Hæmorrhage after Partial Thyroidectomy. After operations on the thyroid gland, hæmorrhage is alarming, not neces-sarily because of the quantity of blood which is lost, but because blood and blood-clot soon compress the trachea.

In all probability the patient has already given signs of anxiety, for blood has come through the dressing. Suddenly she is seized with choking, which may terminate fatally unless help is forthcoming immediately. Reopen the wound and turn out the blood-clot. In extreme instances this should be done in bed ; more often there is time to move the patient to the theatre.

The Search for the Bleeding Point.—On reopening the wound we

may be so fortunate as to locate the bleeding point at once. Usually,
however, serious post-operative hæmorrhage comes from the superior
thyroid artery, which is most inaccessible from the collar incision.
When the bleeding is coming from high up, under cover of the flap
where the superior pole of the thyroid gland would be normally, make
a separate incision over that point. This is about on the level with
the upper third of the thyroid cartilage. The sternomastoid is
retracted laterally, and in the depths of the wound the superior
thyroid artery (*Fig.* 548) soon will be discovered if it is bleeding.
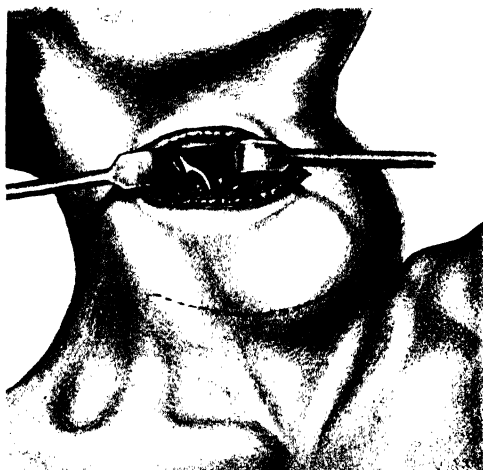
Fig. 548. Post-operative hæmorrhage after partial thyroidectomy.
Exposing the superior thyroid artery.

Prophylaxis. So regularly has post-operative hæmorrhage been
found to arise from a slipped ligature on the superior thyroid artery
that double ligature of this vessel at the time of the operation can
be commended.

Post-operative Thyrotoxæmia. We are called urgently to a patient
who has had an operation for exophthalmic goitre or for the removal
of a toxic adenoma. The pulse is rapid, the temperature is high,
and the general appearance of the patient gives rise to considerable
anxiety. Having ascertained that these symptoms are not the result
of post-operative hæmorrhage, we commence to treat vigorously
the acute post-operative thyrotoxicosis.

Administer intravenously a pint of saline and glucose, to which
has been added 50 to 100 min. of Lugol's solution. If the temperature

is in the region of 103°, ice packs to the limbs are ordered. If the temperature is 104° or more an ice-pack to the whole body except the chest wall sometimes tides the patient over the crisis. The precordial region is a useful situation upon which to apply an ice-pack, but that part of the chest wall overlying the lungs should be avoided. When the symptoms are grave, reopening the wound and packing it lightly with saline-soaked gauze occasionally benefits the patient remarkably. This procedure evacuates toxic serum spilled from the cut surface of the thyroid. As soon as the pulse commences to improve a suitable dose of morphia is prescribed and continuous intravenous saline infusion is commenced.

Acute Thyroiditis.

It is necessary to distinguish two forms of this disease : (1) Acute inflammation of a previously normal thyroid ; and (2) Acute inflammation of a goitrous thyroid (acute strumitis) ; thirty-four per cent belong to Group 2 (Robertson).

In the first place treat the patient conservatively. Suppuration occurs in about half the cases, and the other half resolve. When the general and local signs indicate, an incision must be made. A limited incision of the collar type will be employed. Suppuration in a goitre may give rise to symptoms of impending suffocation, and is comparable, as far as treatment is concerned, to hæmorrhage into a cystadenoma (*see* p. 534).

Fig. 549.—Acute inflammation of a thyroglossal cyst, showing the tendency of the overlying cellulitis to spread laterally. In this case the inflammation subsided with conservative treatment.

Inflammation of a Thyroglossal Cyst.

Acute inflammation is a common complication of a thyroglossal cyst (*Fig.* 549). The accompanying cellulitis tends to spread around the neck like a necklace. Treated expectantly, the inflammation usually subsides. Opening an acutely inflamed thyroglossal cyst (unless no other course is possible) is bad surgery, for the cyst is thereby converted into a fistula. A large proportion of thyroglossal fistulæ are the direct result of mistaking an inflamed thyroglossal cyst for an ordinary abscess.

LUDWIG'S ANGINA

In 1836 Wilhelm von Ludwig described a clinical entity characterized by a brawny swelling of the submaxillary region combined with inflammatory œdema of the mouth. It is the *combined* cervical and intrabuccal signs which constitute the characteristic feature of the condition (*Fig.* 550). It may begin in either situation, but until it spreads from the submaxillary tissues to the sublingual tissues, or in the reverse direction from the sublingual tissues to the submaxillary region, it does not constitute Ludwig's angina.

The essential pathology of the condition is an infection of the closed fascial space about the submaxillary salivary gland.

Course of the Disease. Unless tension is relieved certain cases rapidly assume a grave aspect. The swollen tongue is pushed towards the palate and forwards through the open mouth, while the cervical cellulitis extends down the neck in that most dangerous plane deep to the deep fascia. Only too often, in 12 to 24 hours the patient's life is threatened or taken. At necropsy upon a man of 42 who died of Ludwig's angina soon after admission to the Liverpool Royal Infirmary, Bickersteth found "nothing abnormal superficial to the deep cervical

Fig. 550. Ludwig's angina. The swelling in the submental region, and the inability to close the mouth owing to œdema of the tongue and floor of the mouth, can be seen.

fascia, but beneath that structure a diffuse cellulitis. All muscular interstices and the connective tissue surrounding the trachea were infiltrated with sero-purulent fluid extending upwards to the root of the tongue and downwards to the anterior mediastinum." Cultures show that in about 70 per cent of cases the infecting organism is a streptococcus.

Peculiar Dangers of Ludwig's Angina. Here we are confronted with infection of a fascial space walled in on all sides by dense fasciæ and muscles, a space where clinical experience and experimental injection demonstrate that inflammatory exudate can, and does,

pass via the tunnel occupied by the stylohyoid to the submucosa of the glottis.

The integument allows the inflamed subcutaneous tissue to swell; the cervical fascia is unyielding, and in this respect may be compared to periosteum. Obviously, therefore, if it is logical to decompress immediately the infected area in osteomyelitis it must be doubly so in Ludwig's angina, for in the latter condition there are all the dangers of impending septicæmia combined with a possibility of early œdema of the glottis.

Operation.—Before commencing the operation see that laryngotomy instruments are at hand. As regards the anæsthetic, nitrous oxide gas should be avoided. As pointed out at a coroner's inquest upon a case of Ludwig's angina, gas is a ' spasmodic ' anæsthetic. *Undoubtedly the ideal anæsthetic in this condition is evipan.*

The objective is a communication between the fascial space and the exterior. Early in the disease this can be easily, and often effectively, accomplished in the following way. A deep, really deep, incision is made along the middle two-thirds of a line joining the symphysis menti with the centre of the hyoid bone (*Fig.* 551). A hæmostat is inserted and thrust upwards until its blades protrude almost beneath

Fig. 551.—Ludwig's angina. A de sion in the position indicated, passing to the sublingual mucosa, proved effec this comparatively early case.

the sublingual mucosa. If the disease is limited to one submaxillary triangle the beak of the forceps is directed towards the submaxillary salivary gland of that side. When it is judged that the fascial space has been entered the blades are opened. A drainage tube is passed into the incision and copious dressings soaked in hot magnesium sulphate solution are applied. General treatment follows the usual lines for a severe streptococcal infection.

While operative measures as outlined above, if carried out early, are often satisfactory, it is probable that more thorough decompression of the space would reduce the total mortality of the condition, which at the present time is about 30 per cent. More elaborate decompression is imperative when simple incision fails to

give relief, and it was this circumstance that led Leonardo to make
a wide transverse incision dividing the mylohoid and geniohyoid
muscles. Later, van Wagener and Costello found that primary

division of the cervical diaphragm was attended by excellent results,
and these authors advocate division of the mylohyoid as a standard
measure for established Ludwig's angina. I have adopted their
suggestion in two cases. The technique is as follows : A wide incision

FACIAL ARTER

MYLOHYOID

Fig. 553.—The parts involved in the operation for Ludwig's angina. The
position of the incision is shown. The submaxillary gland is retracted down-
wards. The facial artery is divided between ligatures. The mylohyoid is now
exposed and divided.

is made at the base of the submaxillary triangle following the lower
border of the jaw (*Fig.* 552). The facial artery is identified and
divided between ligatures. The submaxillary gland is retracted and

the mylohyoid muscle divided completely (*Fig.* 553). Often pus will be found under the mylohyoid muscle around the deep prolongation of the submaxillary gland. It may be necessary to carry the incision right across to the other side, and where œdema is extreme to convert the transverse incision into a T by a mid-line prolongation to the hyoid.

In a series of six early cases of Ludwig's angina E. G. Ramsdell has *excised* the submaxillary salivary gland. All the patients recovered. This appears to be a method which can be commended strongly.

BRAWNY CELLULITIS OF THE LOWER TWO-THIRDS OF THE NECK

Ludwig's angina, although no doubt due to a streptococcus, is a *clinical* entity. This being the case, it is customary and correct to confine the use of the term to those cases of virulent cervical cellulitis commencing in the submaxillary triangle. True Ludwig's angina, if it is untreated, may spread down the neck, but the condition to which we draw attention here is a brawny cellulitis *confined to the lower two-thirds of the neck.*

Treatment.— If there is no dyspnœa, commence by applying hot magnesium sulphate fomentations; it is possible that a localized abscess will form. Sometimes operation will become necessary before this happy termination, and there are no definite signs as to where pus will be found. Commence with a mid-line incision at the level of the greatest œdema (*Fig.* 554),

Fig. 554.— The incisions for brawny cellulitis referred to in the text.

and with the finger work laterally. If dyspnœa becomes urgent the mid-line incision may be utilized for laryngotomy, the instruments for which should be at hand ; but opening the air-passages should be avoided whenever possible because of the danger of pneumonia. If a localized induration can be felt on one or other side, make a two-inch incision at the anterior border of the sternomastoid (*Fig.* 554), incise the deep cervical fascia, and gently search with the finger and a blunt director for pus, having due regard to the great vessels. If, as is sometimes the case, only thin, semipurulent fluid is found, suture a soft rubber-dam drain in position. Give the patient a dose of intravenous mercurochrome, and continue to foment the neck. Antistreptococcal serum may be administered with advantage.

Under evipan anaesthesia I made incisions as shown in *Fig.* 554 in the neck of a woman whose condition was desperate. The lower two-thirds of the neck were indurated and of a vermilion hue ; only seropurulent fluid was evacuated. From that time the breathing became less laboured and the general condition improved. Twelve days later a massive stinking slough was extruded from the wounds.

UNCOMPLICATED CERVICAL ABSCESS

(*Suppurating Cervical Lymphatic Glands*)

In dealing with this common condition one can usually delay operation with safety and advantage until the centre of the swelling is soft, or until the overlying subcutaneous tissue becomes œdematous. A comparatively small incision is made, and a pair of sinus forceps thrust through the deep cervical fascia (*Fig.* 555). Tube drainage is employed.
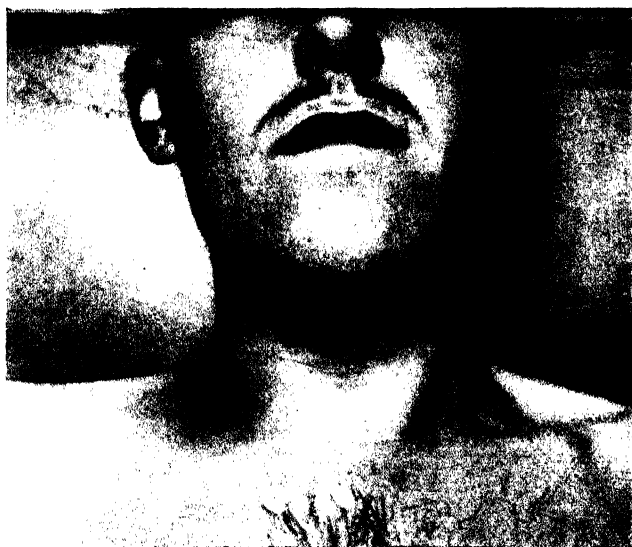
Fig. 55. Suppurating supraclavicular adenitis secondary to a boil over the pomum Adami. Abscess drained by Hilton's method.

Conditions which Simulate Cervical Abscess.—Inflammation may complicate a *branchial cyst.* Such inflammation usually subsides with expectant treatment, after which the cyst should be enucleated. The diagnosis of branchial cyst may be confirmed by aspirating a little of the contents of the cyst. The substance withdrawn looks like pus,

but if a drop is examined under the microscope an abundance of cholesterol crystals will be seen.

Inflammation also complicates *cystic hygroma*, which is usually found in the lower third of the neck, and nearly always in childhood. The diagnosis can be clinched by the translucency of the swelling. Inflammation of a cystic hygroma regularly subsides with expectant treatment.

Acute inflammation of a *thyroglossal cyst* has been discussed on p. 540.

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CHAPTER XXXIII

BLOOD-VESSELS OF THE EXTREMITIES

THE immediate treatment of a wound of any large artery is to apply pressure to the bleeding point with the left thumb whilst the right hand seeks the point of vantage to compress the artery above the wound. In the case of the limbs, when the wound is below the axilla or groin, direct compression is quickly changed in favour of some form of tourniquet. Unfortunately for the patient, it is seldom that skilled help can be procured on the scene of the accident. Thus it comes about that the general diffusion of 'First-aid' knowledge among the public is to be encouraged. Sometimes it happens that a little knowledge is a dangerous thing:

> I was called to see a man dying from hæmorrhage from a wound in the thigh. Before his transit from an outlying district to hospital a tourniquet had been applied *above* the wound. The femoral artery was intact, but there was a large opening into the femoral vein.

LIGATURE OF ARTERIES

Ligature of arteries by classical methods, so long the vogue as a test of knowledge in the examination room, is sometimes out of place in the treatment of the living. If an artery has been divided, it is of the highest importance to expose thoroughly the seat of the injury and to see clearly what one is doing. Working at the bottom of a small, dark hole is difficult and dangerous. Moreover, if an artery has been divided, it is highly improbable that the corresponding vein and a nerve or nerves in the immediate vicinity have escaped. In this work, whenever possible, we have adopted the epoch-making methods of exposing arteries evolved and employed by Fiolle and Delmas during the European War. These exposures are designed to reveal deep-seated blood-vessels without mutilation.

Should the Corresponding Vein be Ligatured also?—Accumulated evidence indicates that liability to gangrene is lessened by occluding the corresponding vein. Sir George Makins, in a study of a large number of cases of ligature of main vessels, found 28 per cent developed gangrene when a main artery was ligatured alone, but this percentage was reduced to 19·7 when the corresponding vein was also occluded.

Ligature of a Large Artery: the Stay-knot of Ballance.—This special knot is useful in the case of large arteries. Two independent ligatures

are placed close to one another. The first tie concerns each ligature only, the second is made in conjunction. *Fig.* 556 will make this clear.
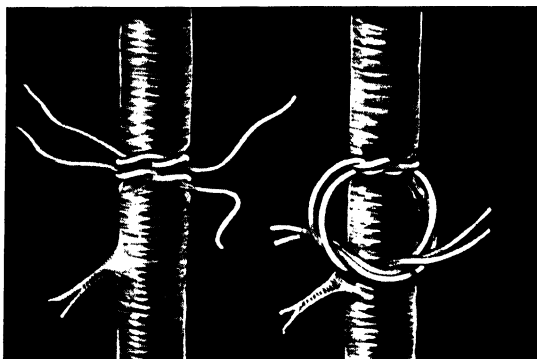
Fig. 556.—Ballance's stay-knot.

VASCULAR SUTURE

Suture of a wounded vessel is not so difficult as is sometimes assumed. The results in properly selected cases are superior to those of simple ligature. In the case of injury of large veins suture is simple and satisfactory. Suture of wounded arteries is called for especially in the case of the external iliac, common femoral, and common carotid.

A knowledge of arterial suture is also of great importance in civil practice by reason of the good results which have followed removal of emboli from arteries supplying the extremities.

Methods of Temporarily Occluding an Artery.—Before an artery can be sutured it is necessary to occlude it temporarily.

Fig. 557.—Crile's arterial clamp forcep.

Fig. 558.—Temporary occlusion of a large artery by Gordon-Taylor's method. A, Rubber drainage tube; B, Tape tied with a single turn.

The following methods are in use : —

1. Crile's arterial clamp (*Fig.* 557).
2. A length of tape passed around the artery and held moderately taunt by the assistant.
3. Gordon-Taylor's method (*Fig.* 558).
4. Short hæmostats with blades covered with close-fitting rubber tubing (*Fig.* 562).

If Crile's arterial clamps are not available, probably Methods 2 and 3 will be found most generally useful. Method 2 is indicated particularly in short operations such as passing a stitch or two to close a puncture, while Method 3 is valuable for procedures occupying more time, and when assistance is limited.

Suture Material—No. 0000 untwisted Chinese silk; No. 12 needle. After sterilizing treat the suture with sterile vaseline. Fine catgut has been used with success on many occasions. In using catgut, interrupted stitches are best, for if one breaks, the whole suture line is not ruined.

Provision Must be Made to Prevent Clotting.—The wound is drenched with sodium citrate. Sterile liquid paraffin answers well, but has the disadvantage that it makes everything so slippery.

The principal indication for arterial suture in civil practice is embolectomy, which will presently receive detailed attention.

END-TO-END ARTERIAL ANASTOMOSIS

While repair of a wound or a deliberate incision of a large artery should receive the fullest consideration in a work on emergency surgery, indications for performing end-to-end arterial anastomosis in civil life are so infrequent that we propose to dismiss the subject
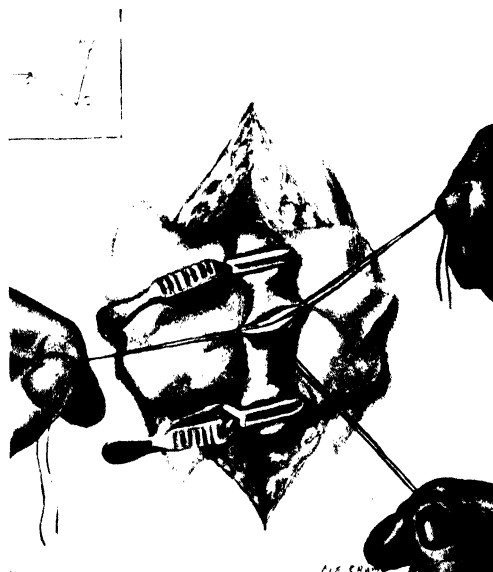
Fig. 559. —End-to-end arterial sutu   Three stay-sutures have been inserted.

briefly. Arteriorrhaphy is indicated chiefly in the case of the common femoral in order to save a young patient the possibility of gangrene. The subject must be young. The operation is not applicable when the artery is sclerotic.

Temporary clamps are applied as before. The ends of the arteries are trimmed, any excess of adventitia being cut away. This is followed by lightly smearing the cut ends and interior of the ends of the vessel with sterile vaseline on a minute gauze swab. Three stay-sutures are passed at equidistant points so that when they are pulled taut a triangle is formed (*Fig.* 559). The portions A–B, B–C, and C–A shown
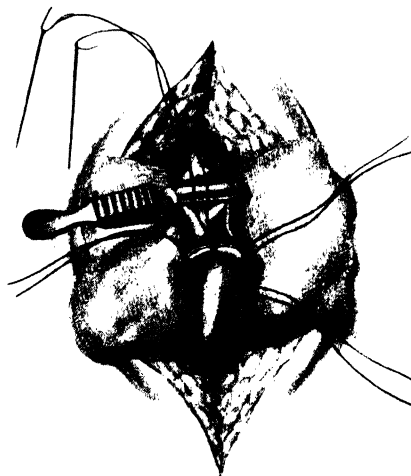
Fig. 560.—End-to-end arterial suture. The edges of the artery have been approximated by a mattress suture.

in the inset are sewn separately, using a mattress suture to evert the edges (*Fig.* 560). This eversion forms an ideal junction, endothelium being opposed accurately to endothelium.

EMBOLECTOMY

The restoration of the circulation by the removal of an embolus is perhaps the most notable advance in urgent surgery during the past decade. In Scandinavia, the home of embolectomy, physicians and practitioners send their cases to the surgeon early enough for the operation to be performed frequently and successfully. In England the possibilities and urgency of arteriotomy are not yet fully appreciated. Doubtless it will soon be recognized that embolectomy is as urgent as the closure of a perforated gastric ulcer. (For PULMONARY EMBOLECTOMY *see* p. 444.)

For a hopeful issue the embolus should be removed within six hours. After the twelfth hour the chances become increasingly slender, for the intima becomes damaged and thrombosis occurs, rendering it impossible to remove all the clot; furthermore, by this time gangrene has commenced in many instances (*Fig.* 561). Thus it comes about that embolectomy is never successful after the twenty-fourth hour.

Usually an embolus lodges where an artery divides. The bifurcations of the aorta, common iliac, femoral, and popliteal arteries are favourite sites. Another common situation is the axillary artery where the subscapular branch is given off.

The operation can be performed under local or spinal anæsthesia, and this is preferable, for the patient is usually weak, or suffers from heart disease. No instrument not in common use is required, but

Fig. 561.—Too late for embolectomy! An embolus became lodged in the common femoral artery forty-eight hours before the patient's admission to hospital. The patient was a young woman with mitral stenosis.

the surgeon should provide himself with a pair of fenestrated gall-stone forceps, a ureteric catheter, and material suitable for arterial suture (*see* p. 549).

The artery is exposed at the point where the embolus is believed to be arrested, or, in the case of the external and common iliac arteries, the femoral artery is exposed. The wound is flooded with citrate solution, which is also used to keep moist the instruments and the pads which are clipped to the wound edges.

If that part of the artery containing the embolus has been displayed, its proximal end will be seen to pulsate while its distal end is still. If the artery does not pulsate, we know that the embolus lies above the area exposed. The artery having been occluded temporarily above and below by one of the methods described (p. 548 and *Fig.* 562), it is opened by a longitudinal incision, preferably *above* the embolus, for here the intima is undamaged. All available clot is

picked out with forceps. The upper clamp is then loosened and the blood allowed to spurt for a moment to wash out any remaining clot. Similarly the lower clamp is now loosened and the blood flows, if there is sufficient collateral circulation to fill the distal part of the vessel. Temporary occlusion of the vessel being again invoked, the wound is mopped dry of blood and once more drenched in sodium citrate solution. The wound in the artery is then sutured, and if the junction proves watertight the clamps are removed. It may be necessary to reinforce the line of suture with an interrupted stitch.

Fig. 562.— Embolectomy. The field of operation ready for removal of an embolus from the femoral artery. (*After Pemberton.*)

When satisfactory closure has been effected it is necessary to investigate the circulation of the limb. Handling of an artery causes vasoconstriction, and a poor circulation may be due to this cause. Tying the corresponding vein tends to improve the blood-supply to the limb. If no improvement occurs, there may be a second embolus further down, and the question of the advisability of exploring the artery more distally arises.

When the circulation is deemed satisfactory, or the condition of the patient demands a conclusion of the investigation, the skin incision is closed, leaving a loop of silk around the upper part of the artery as a precautionary measure in the event of secondary hæmorrhage.

Complications and Difficulties.—

The Embolus has been Removed, but there is a Quantity of Thrombus in the Distal End of the Vessel. —After clamping the artery some distance from the original incision, a second incision is made, and the lumen washed through with citrate solution (*Fig.* 563).

The Artery is Opened and is found to be Empty, or contains Thrombus only.—Remember the embolus is probably situated above a division of the vessel. Retrograde probing may break up and dislodge the embolus, a ureteric catheter being useful for the purpose. In the case of the lower limb, before retrograde probing is attempted, *the opposite femoral artery must be exposed and temporarily clamped* (*Fig.* 564). The catheter having been passed up the lumen, it is worked about until a gush of blood sweeps out the embolus. After all clot has been evacuated in this manner the vessel is sutured; then the opposite
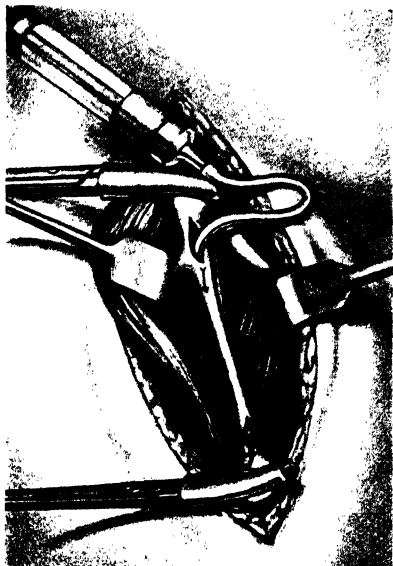
Fig. 563. — Embolectomy. Washing t thrombus from below the embolus in ase of some standing. (*After Pemberton.*)

femoral artery which has been already exposed is opened, and sutured when it has been ascertained that its lumen is free from clot.

An Aortic Embolus is Present. —Aortic embolus may sometimes be dislodged by the method of Pemberton. After temporary ligature of both femoral arteries, an ample incision is made above and parallel to Poupart's ligament. The peritoneum is pushed upwards, and after the bifurcation of the aorta is reached, the clot, which is palpable

Fig. 564. —Embolism in the lower limb. If the femoral artery is found empty, the other femoral artery must be exposed and clamped before retrograde probing is attempted.

through the vessel wall, is 'milked' downwards by the fingers, as shown in *Fig.* 565. One could hardly perform three incisions under

local anæsthesia. Unless spinal anæsthesia has been employed it would be more humane to administer a general anæsthetic if this method has to be used.

Fig. 565. 'Milking' down an aortic embolus through a retroperitoneal approach. (Pemberton—by kind permission of ' Annals of Surgery'.)

The Exposed Artery is Obviously Calcified.—Treatment by arteriotomy and suture is impracticable. Attempts have been made to dislodge the embolus by breaking up the clot through the vessel wall. This is a dangerous practice. Amputation is preferable.

EXPOSURES OF ARTERIES WHICH SUPPLY THE UPPER LIMB

The Subclavian and Axillary Arterial Trunk. —

Fig. 566.—Digital compression of axillary artery. (Marwedel.)

The artery can be compressed digitally in the manner shown in *Fig.* 566.

Position of the Patient.—The patient lies with his shoulder projecting over the edge of the table. A small, narrow sandbag is placed under the upper thoracic spines. An assistant supports the arm held at right angles to the body.

Incision.—The incision is made through skin only, and consists of two distinct cuts. The first is parallel to and half an inch above the upper border of the clavicle. Secondly, the axillary extension of the incision is made : begin one inch to the outer side of the inner end of the

supraclavicular incision, and pass downwards towards the insertion of the pectoralis major (*Fig. 567*).

Division of Muscles. —The pectoralis major is divided completely from the clavicle downwards. By slightly abducting the arm this muscle is put on the stretch and is severed with a few touches of the knife. The pectoralis minor is hooked up on the finger, as in complete amputation of the breast. This muscle is divided completely, also. The fascia is incised from the clavicle downwards, and branches of the thoracic axis artery are secured as necessary. It is highly important to see that the pectoralis major has been completely severed right up to the clavicle.

Fig. 567. Incision for exposing the subclavian and axillary arterial trunk.

Section of the Clavicle. The clavicle is divided as near as possible to its inner extremity. The point of division should be touching the clavicular head of the sternomastoid (*Fig. 568*). Clear this point with a periosteal elevator. Slip a retractor under this portion of the clavicle and bore two holes through the bone from below upwards about three-quarters of an inch apart. Then divide the clavicle between the two holes with a Gigli's saw or chisel. If the chisel is used, keep the retractor protecting the subclavian vessels.

At this stage, if the entire pectoralis major has been divided, the axillary space opens like a book under the mere weight of the arm (*Fig. 569*). A few fibres of the subclavius alone need division to give the most perfect exposure of an otherwise inaccessible region.

Reconstruction. —While the assistant raises the shoulder, the clavicle is united with kangaroo tendon or silver wire. The pectoralis

minor is approximated with a running suture. The pectoralis major is drawn together by three or four deep mattress sutures tied moderately tightly. If drainage is necessary, a stab is made in the axilla for the tube.
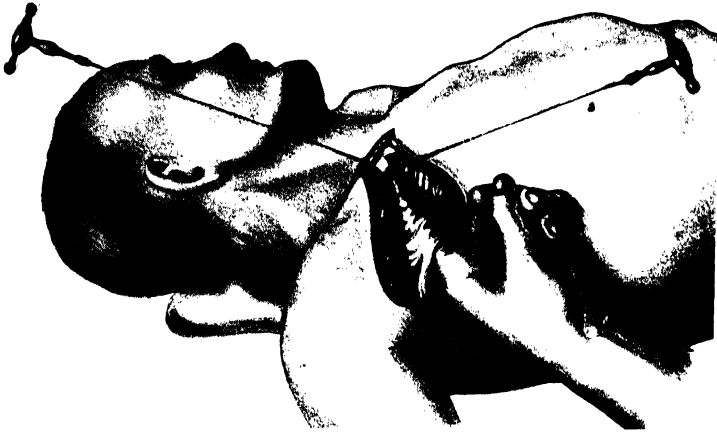
Fig. 568. Exposure of the subclavian and axillary arterial trunk. Dividing the pectoralis minor and the clavicle. (*After Fiolle and Delmas.*)

Fig. 569. Exposure of the subclavian vessels and the brachial plexus. (*After Fiolle and Delmas.*)

The Third Part of the Axillary and the Brachial Artery.—

The brachial artery can be compressed digitally in the manner shown in *Fig. 570.*

Position of the Patient.—The arm should be supported at right angles to the body by an assistant. To rest the patient's forearm upon a small table (*Fig. 571*) is convenient, and prevents fatigue of the assistant. The arm between the axilla and elbow must not be supported. The surgeon may be seated facing the inner side of the arm.

Incision.—An ample incision is made in the line of the artery between biceps and triceps, but hugging the inner border of the biceps.

Fig. 570.— Digital compression of brachial artery. (*Marwedel.*)

The fascia having been divided, the overlapping innermost fibres of the biceps are drawn upwards with a retractor. The median nerve is isolated and kept out of the way (*Fig. 572*). The brachial artery with its two venæ comites is exposed. The artery may be much

of patient for ligature of the brachial artery. Note that the upper arm is unsupported.

smaller than expected. It is sometimes duplicated, as I found in one case when performing peri-arterial sympathectomy. Other anomalies may be present. The artery should be isolated from the venæ comites if it has been decided that ligature is necessary.

Apart from local wounds, ligature of the brachial is to be recommended in cases of secondary hæmorrhage from wounds about the

elbow and the forearm. Perhaps the chief indication for ligature of the brachial is hæmorrhage from the *deep palmar arch*.

The Brachial Artery in the Antecubital Fossa.—The arm is held or supported on a table. The operator stands or sits on the outer side. An incision is made along the inner border of the tendon of the biceps. The median basilic vein is pushed aside and the bicipital fascia divided. *Now partially flex the elbow.* On the brachialis anticus is the brachial artery with the median nerve lying to its inner side. If the bleeding point is inaccessible, the incision can be prolonged in a downward direction, in the manner about to be described.
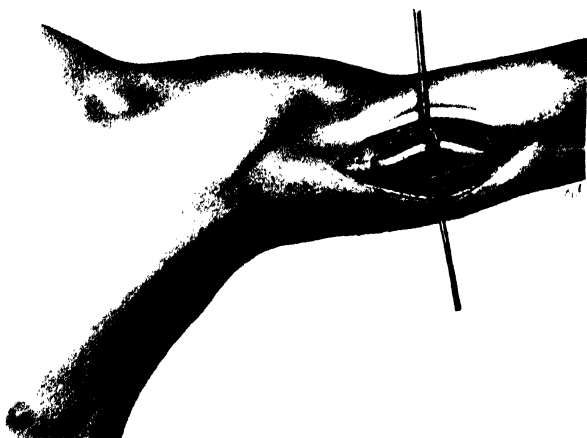
Fig. 572. Exposure of the brachial artery. The median nerve has been hooked upwards.

The Termination of the Brachial Artery; the Radial, Ulnar, and Interosseous Arteries in the Upper Third of the Forearm.—In wounds of the upper third of the forearm it is impossible to determine whether the termination of the brachial, the radial, the ulnar, or the posterior interosseous artery is the source of severe arterial hæmorrhage. It is obviously desirable to expose all the vessels, which can be done in the following way.

Position of the Patient and Incision.—The arm is placed on a table after the manner described above, or it is held away from the trunk by an assistant. The operator stands on the outer side of the limb. The incision begins an inch above the fold of the elbow. It proceeds along the inner side of the biceps tendon, then, passing down

the middle of the forearm, it curves towards the middle third of the
radius, where it ends (*Fig.* 573).

Fig. 573.   Position of patient and incision for exposing the

The incision is deepened
and the median basilic vein
ligatured. The bicipital fascia
is divided and the median
nerve comes into view. The

Fig. 574.   Exposure of
the termination of the brachial
artery.   The radial, the ulnar,
and the commencement of the
interosseous arteries are dis-
played by suitably retracting
the pronator radii teres and
the supinator longus.
   (*After Fidle and Delmas.*)
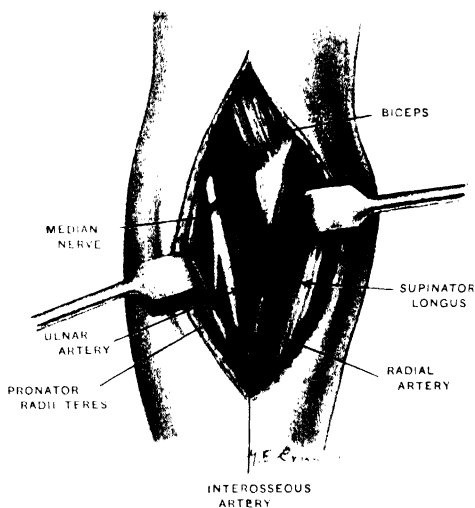
pronator radii teres is retract-
ed, and on the outer side of
the median nerve the brachial
artery will be seen.   Place a
second retractor under the

supinator longus. With the finger break through the extremely loose
cellular tissues between these two muscles. The bifurcation of the
brachial artery is clearly demonstrable. The radial artery under cover
of the supinator longus is readily exposed. The ulnar artery, the larger
vessel, lies more deeply. *Pronate the forearm strongly.* Under these
conditions strong retraction of the pronator radii teres opens up the
area marvellously (*Fig.* 574). With a little dissection the ulnar artery
can be followed as it lies on the flexor profundus digitorum for five
or six inches. Near the bifurcation one can see the origin of the
interosseous artery for a short distance.

Reconstruction.—As nothing of importance has been divided, it is
only necessary to unite the fascia and the skin.

ULNAR
ARTERY

RADIAL
ARTERY

FLEXOR CARPI ULNARIS
RETRACTED
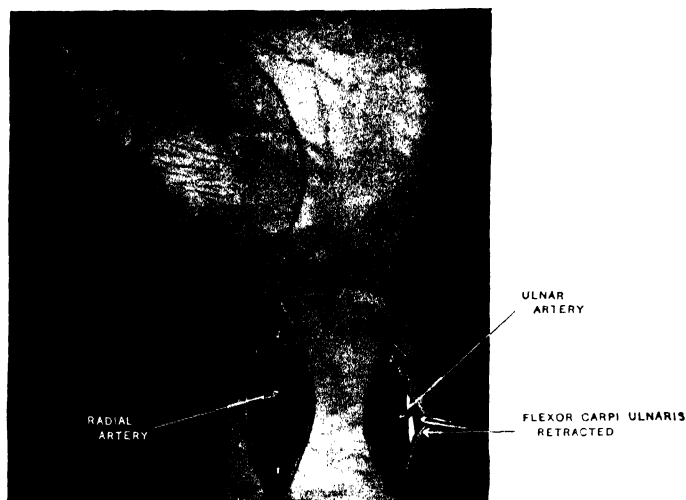
Fig. 575. —Exposure of the radial and ulnar arteries at the wrist.

The Radial and Ulnar Arteries in the Lower Third of the Forearm

(*Fig.* 575).—The arm should be supinated fully and resting on a table.

The Radial Artery.—This part of the radial artery is readily
exposed in the line of the pulse—that is, between the supinator
longus and the flexor carpi radialis.

The Ulnar Artery.—Commence at the pisiform bone, and make
an incision along the radial side of the flexor carpi ulnaris. After the
wrist has been flexed the flexor carpi ulnaris is drawn to the ulnar
side, and the ulnar artery is then exposed.

The Arteries of the Palm.

—It is inadvisable to ligature the ulnar
and radial arteries for severe palmar hæmorrhage. A case in point
occurred in my practice.

The patient had a sarcoma of the first metacarpal. A piece was removed for section and severe hæmorrhage occurred. The radial and the ulnar arteries were tied, and the patient was transferred to hospital some miles distant. On arrival the dressings were soaked in blood, and the patient by this time was severely anæmic. After blood transfusion the arm was amputated. *Fig.* 576 shows the condition of the hand. The incision for ligature of the radial and ulnar arteries can be seen.

Fig. 576. A case of fungating sarcoma of the first metacarpal bone in which ligature of the radial and ulnar arteries at the wrist failed to stop hæmorrhage.

Uncontrollable hæmorrhage below the wrist is best treated by ligature of the brachial artery.

EXPOSURES OF ARTERIES WHICH SUPPLY THE LOWER LIMB

Hæmorrhage from the iliac arteries can be controlled in a thin subject by compressing the abdominal aorta against the spine with the fist applied to the abdominal wall.

The External Iliac.—An incision is made half an inch above Poupart's ligament. It is a long incision, and is comparable to that for femoral herniotomy by Lotheisen's method, but in this case the incision curves upwards somewhat towards the anterior superior iliac spine (*Fig.* 577). The aponeurosis of the external oblique is exposed and divided in the length of the incision. The conjoint tendon is defined. Those fibres of the internal oblique attached to Poupart's ligament are made taut by retraction (*Fig.* 578) and divided close to Poupart's ligament. This exposes the fascia transversalis. The deep epigastric vessels may be avoided, but it is usually best to divide them between ligatures. The division of these vessels opens up the plane between the transversalis and the peritoneum. After working in this plane with the finger the fascia transversalis is divided. The remainder of the exposure is performed entirely with the fingers. The peritoneum is lifted up and gently eased until the external iliac vessels are in full view (*Fig.* 579).

Ligature of the external iliac artery is required only exceptionally. It is sometimes a futile method of stopping bleeding from a wound of the thigh, for often anastomotic circulation allows renewed hæmor-

Fig. 577. —Incision for ligaturing the external iliac artery. Ligature of the artery was actually performed in this case of malignant glands of the groin for a torrential hæmorrhage following erosion of the common femoral artery by malignant ulceration. The growth receded for a time after the ligature. The photograph was taken two days before the hæmorrhage.

rhage ; wounds of the common femoral should be attacked directly. Ligature of the external iliac artery should be reserved for secondary
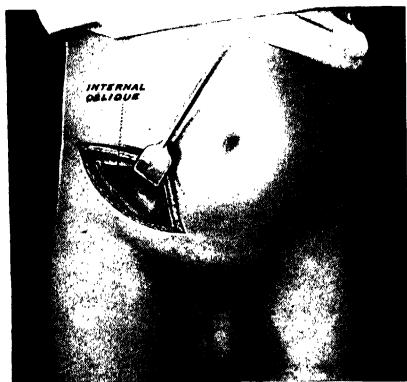
Fig. 578.—Exposure of the external iliac artery. The internal oblique has been retracted upwards. The peritoneum has now to be peeled off the external iliac vessels with the finger.
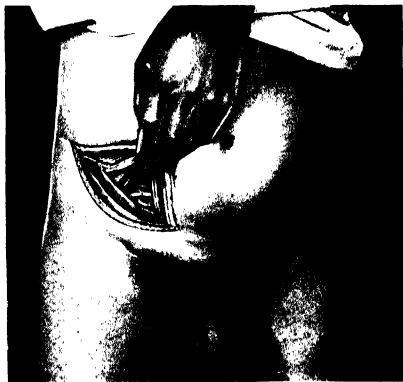
Fig. 579.—Exposure of the external iliac vessels. The deep epigastric vessels have been ligatured ʃ internal oblique aris ment have been div led. The periton is being pushed upw rds with the fingers.

hæmorrhage from an infected wound high up in Scarpa's triangle, or for malignant ulceration involving the main vessel in this situation.

A. W., aged 51, had an indurated ulcerating mass in the groin (*see Fig. 577*). No primary focus could be discovered. Two days after admission a violent arterial hæmorrhage occurred. A dressing over a tight bandage partially controlled the hæmorrhage. The external iliac artery was ligatured and the hæmorrhage ceased. The patient was treated with deep X-ray therapy, without much benefit.

THE FEMORAL ARTERY

The femoral artery is compressed digitally in the manner shown in *Fig.* 580.

The Upper Two-thirds of the Femoral Artery.—Exposure of the upper two-thirds of the femoral artery presents no difficulty. The surface marking is from a point mid-way between the symphysis pubis and the anterior
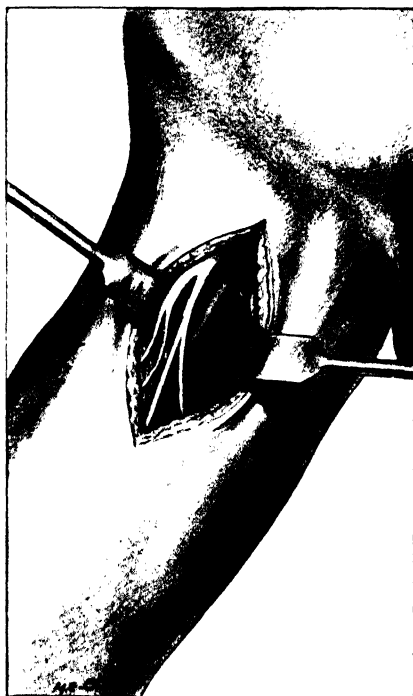
superior iliac spine to the adductor tubercle, with the limb slightly flexed at the knee and externally rotated. An incision is made on this line. After incising the fascia the sartorius is

Fig. 581.—Exposure of the femoral vessels.

identified, mobilized with the finger, and then retracted inwards. With a little dissection the femoral artery and vein are identified easily, and can be traced upwards or downwards as circumstances demand (*Fig. 581*).

Ligature of the common femoral artery is looked upon with disfavour. Certainly vascular suture should be employed if practicable. If the femoral artery has to be ligatured, it is generally conceded that ligature of the femoral vein is indicated also. It has been shown (p. 547) that the incidence of gangrene is less when the corresponding vein has been tied in addition to the artery.

I was called to see a girl of 13 who had had an operation for osteomyelitis of the lower third of the femur fourteen days earlier. Twelve hours previously considerable hæmorrhage had occurred from the wound, but this had been controlled by packing. An hour previously violent hæmorrhage had occurred, and a tourniquet was in place around the thigh. She was very blanched and the pulse was 140 and poor. The tourniquet was loosened, and as no arterial hæmorrhage occurred we decided to perform blood transfusion first. As soon as a compatible donor had been procured the tourniquet was reapplied and the transfusion carried out. The patient was then anæsthetized with gas and oxygen, and the femoral artery exposed in the middle third of the thigh. The artery and the vein were ligatured above the anastomotica magna. Probably as the result of the blood transfusion, the convalescence of the patient, which had been slow, was much enhanced.

The Lower Third of the Femoral Artery and the Upper Half of the Popliteal Artery. The following method is designed to expose the femoral artery where it passes through the opening in the adductor magnus. Incidentally, it gives good exposure of the upper half of the popliteal artery.

Position of the Patient.—This is most important. He is placed as near as possible to the edge of the table. The assistant grasps the lower leg and foot, flexes the knee, and abducts and at the same time externally rotates the thigh. The surgeon stands on the inner side of the limb facing the region to be explored. The only necessary landmark is the tendon of the adductor magnus.

Incision.—Palpate the upper edge of the internal condyle, feel the tendinous insertion of the adductor magnus, trace the tendon upwards along this line. Commencing at the insertion, make an incision six inches long.

In the upper part of the incision the sartorius will be seen. Mobilize this muscle with the finger. Run the finger upwards and downwards on the under surface of the tendon of the adductor magnus, cleaning it within the limits of the incision. When the muscle is clearly defined, with the scalpel open the aponeurotic roof of Hunter's canal close to the upper and external border of the adductor magnus tendon. Place two hæmostats on the edge of the tendon and draw it towards you. Then place two more hæmostats on the divided aponeurotic roof of Hunter's canal, and give them to an assistant to retract away from you. With blunt dissection the femoral vessels can

be traced from Hunter's canal through the opening in the adductor magnus, right on into the depths of the popliteal space (*Fig.* 582). It will be noted that the only guide is the tendon of the adductor magnus. If this is remembered, there is no difficulty in exposing clearly the whole course of the artery in this inaccessible situation.

LONG SAPHENOUS NERVE
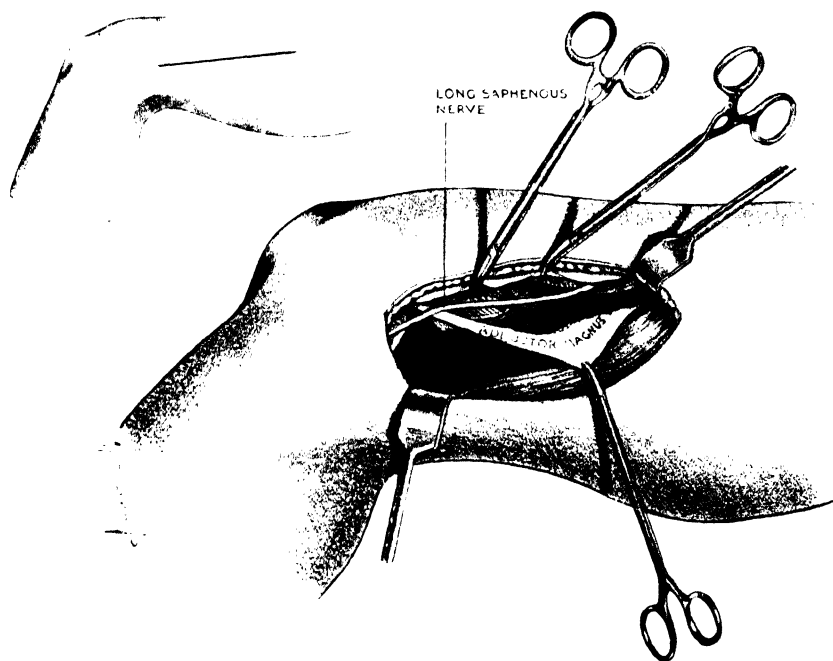
ADDUCTOR MAGNUS

FIG. 582.   Exposure of the femoral artery as it passes through the opening in the adductor magnus. A large part of the popliteal artery is also available. The tendinous expansion of the adductor magnus has been drawn towards the operator, while the aponeurotic roof of Hunter's canal has been drawn away to expose the femoral vessels. (*After Fiolle and Delmas.*)

The Lower Third of the Popliteal Artery, together with the Origins of the Anterior Tibial, the Posterior Tibial, and the Peroneal Arteries.—

Position of the Patient. The patient lies on his abdomen, and the assistant holds the foot so as to be able to flex the knee at the proper time, and thus relax the gastrocnemius and the soleus.

Incision. This is shown in *Fig.* 583.

The short saphenous nerve and vein are isolated and retracted to one side. The interval between the heads of the gastrocnemius is identified and these muscular bellies are separated. In the upper part of the wound the bellies come apart readily with the handle

of the scalpel ; in the lower part the knife edge must be used. The bellies are widely separated by retraction. The popliteal vessels and nerve are dissected in the upper part of the wound. They are traced until they pass down the tunnel behind the soleus. Under the soleus at this point a director is passed (*Fig.* 584). Keeping rather nearer the tibia than the fibula, the soleus is split on the director. The popliteal artery can now be followed downwards. The artery can be seen dividing into its anterior and posterior
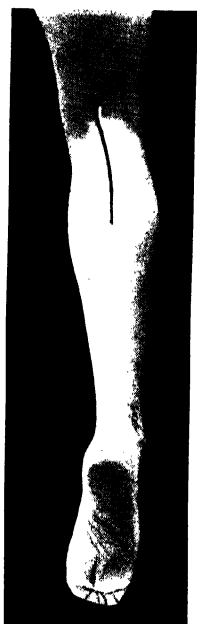
Fig. 583. Incision for exposing the popliteal artery and the commencement of its terminal branches — namely, the anterior tibial, the posterior tibial, and the peroneal arteries.

tibial branches, and from the latter the origin of the peroneal artery can be displayed. If any of these divisions of the popliteal is bleeding, it can be ligatured. Thus the popliteal artery itself may be spared, which is most desirable, for ligature of this artery in

Fig. 584. Exposu...　　lo...　　of the popliteal artery and the　　its pos...　　tibial, anterior tibial, and per...　　inals.　　soleus muscle is about to be　　a dire...　　(*After* *Fiolle and Delmas.*)

its lower third is followed by gangrene of the foot in more than 25 per cent of cases.

The Blood-vessels of the Posterior Aspect of the Leg (Posterior Tibial, Peroneal, and Posterior Interosseous).—

Position of the Patient. The patient lies on his abdomen with his foot over the end of the table. The operator stands at the foot of the table in order to view the leg longitudinally.

Incision.—This commences two finger-breadths below the fold of the knee-joint. It is carried downwards between the heads of the
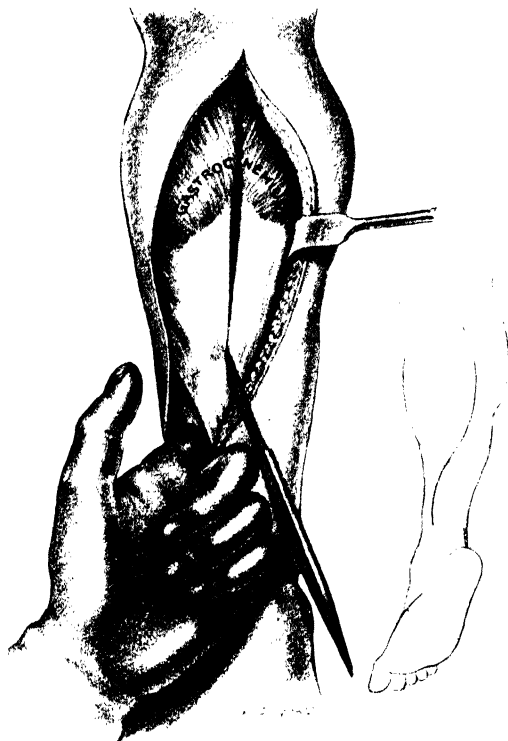
Fig. 585.   of the posterior tibial artery. Splitting the gastrocnemius.
(In   The incision.) (After Fiolle and Delmas.)

gastrocnemius and ends on the inner side of the tendo Achillis, one inch above its insertion.

The external saphenous vein and nerve are identified and retracted outwards. The nerve is situated between the heads of the gastrocnemius and is a good guide to the interval between the two bellies. Commence at the lower end of the incision. Divide the fascia on the inner side of the tendo Achillis. Push the finger upwards in the

loose connective tissue on the deep surface of the tendon. This carries one up to the anterior surface of the soleus. Here the finger remains as a guide. Separate the heads of the gastrocnemius, splitting the muscle with the scalpel (*Fig.* 585). Then divide the soleus strictly in the middle line; the finger beneath allows this to be done boldly. As long as these muscles are divided exactly in the middle
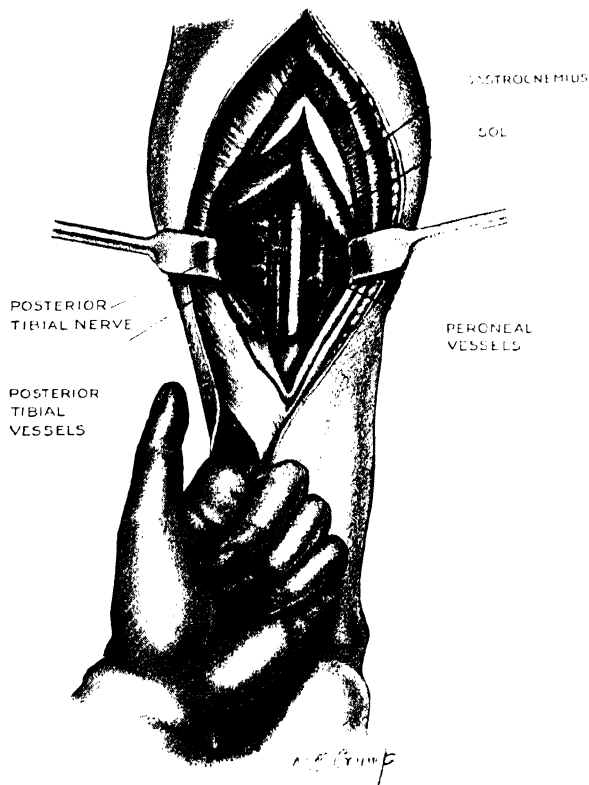
Fig. 586. Exposure of the posterior tibial vessels and nerve, and t vessels. The gastrocnemius and the soleus have been s . (*After Fiolle*

line no harm will result in this extensive incision. When the gastrocnemius and soleus have been divided, the tendo Achillis can be split down its middle as far as the wound allows. Retractors are now inserted. Under a thin layer of fascia the posterior tibial nerve will be seen. On its inner side are the posterior tibial vessels. Half an inch on the outer side the peroneal vessels will be seen (*Fig.* 586).

Reconstruction. This is performed easily with a few interrupted sutures in the muscles. The tunnel on the inner side of the tendo Achillis, made by the finger burrowing upwards, can be used for drainage if necessary.

The Anterior Tibial Artery. —

Incision. Palpate the head of the fibula, then the crest of the tibia, at the same level. In the intervening space between these bony points lie two muscular masses—a large inner, the tibialis
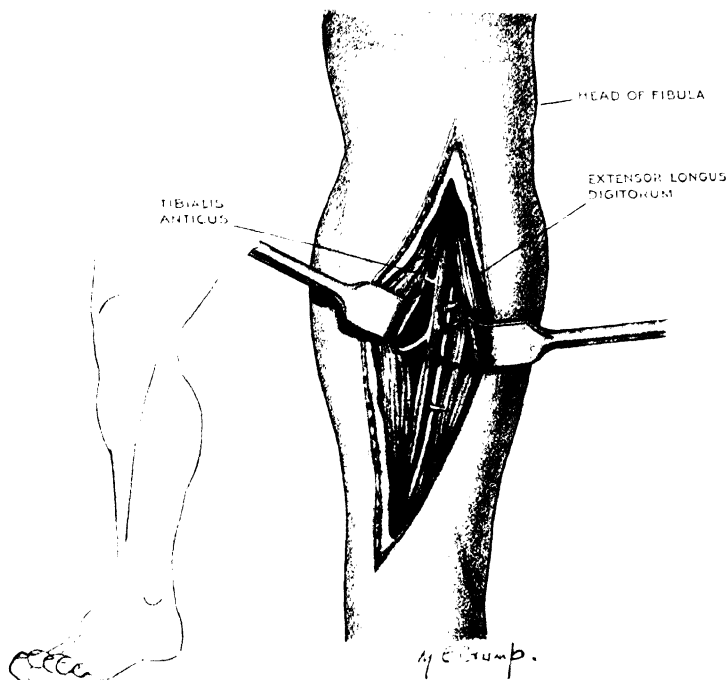
Fig. 587. Exposure of the anterior tibial vessels. (*Inset*—The incision.) (*After Fiolle and Delmas.*)

anticus, and a smaller outer, the extensor longus digitorum. The incision commences in the depression between these two muscles at the level of the head of the tibia. It proceeds downwards to the lower part of the middle third of the tibia, almost imperceptibly approaching the tibial crest as it does so.

Commencing towards the lower end of the wound, identify the two muscles. Dissect them apart, then, with the finger below, aided by a few touches of the scalpel on the surface, completely separate

the tibialis anticus from the extensor longus digitorum in the whole
length of the incision. Retract these muscles strongly and the
anterior tibial vessels and nerves are in full view (*Fig.* 587).

Fig. 588.—Incision for exposing vessels concerned in a subgluteal hæmatoma.
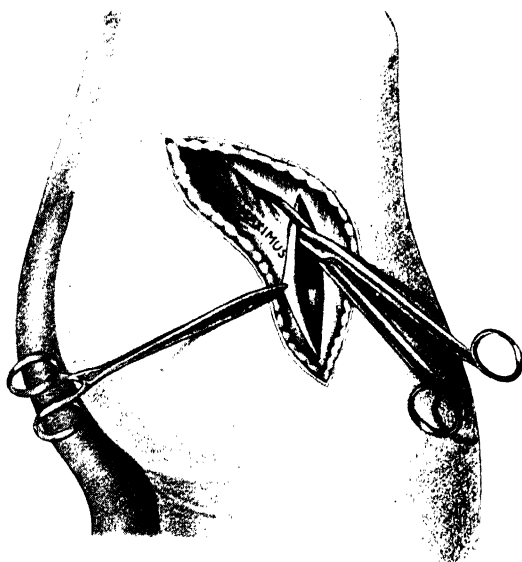
Fig. 589.—Exposure of the gluteal and sciatic arteries. The aponeurosis
over the great trochanter has been incised, and the aponeurotic expansion of
the gluteus maximus is being divided with scissors. (*After Fialle and Delmas.*)

Subgluteal Hæmatoma: Exposure of the Gluteal, Sciatic, and possibly Internal Pudic Arteries.—In wounds of the buttock with a large subgluteal hæmatoma it is impossible to tell which of these arteries is bleeding. Consequently, a wide exposure which displays the anatomy of the region is desirable.

Position of the Patient. The patient is placed upon his abdomen and a flat pillow is placed under the pelvis on the affected side. An assistant slips his hand under the knee, and with the other hand holds the foot. By externally rotating the thigh he is able to relax the gluteal muscles.

GLUTEAL ARTERY

GLUTEUS MAXIMUS

SCIATIC ARTERY
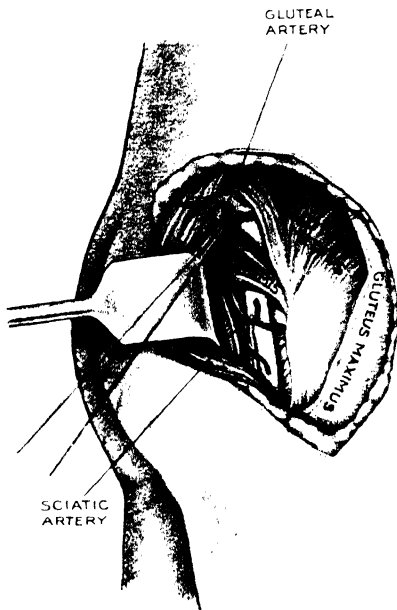
Incision. *Fig.* 588 shows the incision. It commences over the middle of the great trochanter, sweeps upwards, and then passes in a curve to the posterior superior iliac spine.

After fat has been cleared away, the fibres of the gluteus maximus will appear in the upper part of the wound, while in the region of the great trochanter very white, tough fascia will be observed. Concentrate on this fascia. Incise it vertically over the great trochanter. In so doing a bursa is often opened. Pass the finger under

the fascia and it will enter a large potential space beneath the gluteus maximus. Aided by the finger beneath, detach the gluteus maximus with scissors (*Fig.* 589), cutting as near as possible to the iliac crest where the muscle is mainly aponeurotic. Once the gluteus maximus is detached and drawn backwards with a large retractor, the underlying structures are accessible (*Fig.* 590). Seek the pyriformis muscle. With a little blunt dissection the superficial division of the gluteal artery can be seen going to the deep surface of the gluteus maximus. If the superior edge of the gluteus medius is lifted up with a retractor, the deep division of the artery will be found, and the main trunk, coming out of the sacro-sciatic notch, will soon be traced. The main trunk can be ligatured here when necessary. Emerging from below the pyriformis is the sciatic artery. Deeply placed, winding around the spine of the ischium, is the internal pudic artery with the pudic nerve and nerve to the obturator internus. For a very short part of its course the internal pudic artery is available from this aspect.

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CHAPTER XXXIV

BONES

COMPOUND FRACTURES

IMMEDIATE operation is as imperative for a compound fracture as it is for a perforated gastric ulcer. The results of compound fractures in general are still not as good as they might be. The fault is twofold. The urgency of operation is not stressed universally, and experience shows that these cases are too often relegated to junior

Fig. 591. — Compound fracture. Excising the lacerated edges of the wound

house surgeons and others with insufficient knowledge to enable them to deal with such injuries effectively. Compound fractures are among the most urgent surgical emergencies, and after efficient operative treatment, undertaken immediately, results are excellent.

While the patient is awaiting transportation, an antiseptic dressing is applied to the wound. Tincture of iodine on a dry gauze pad cannot be bettered. As soon as the patient has been conveyed to the operating theatre he is anaesthetized. While a gauze swab moistened with iodine is held over the wound, the surrounding skin is shaved, washed with alcohol or petrol (it is advisable to avoid water) and afterwards with ether, and finally treated with tincture of iodine. Towels having been arranged, attention is directed to the wound.

OPERATIVE TREATMENT

Compound Fractures without Gross Contamination. Fill a syringe with methylene-blue solution, and by this means flood the wound with the dye. Wait a minute, then mop the wound dry. Aniline dyes stain bruised or dying tissue more readily than healthy tissue. With curved scissors excise the skin edges (*Fig.* 591). Excise all subcutaneous tissue stained blue, and likewise trim every fibrous structure and muscle until the whole contents of the wound present a clean-cut appearance. If the bone-ends are accessible cleanse them carefully by cutting off loose tags of periosteum, but in general it should be the rule to disturb the bone as little as possible. Taking this maxim into consideration, gently prise the fragments into position, but if the desired position is not maintained rely upon extension as described below. Small fragments of bone lying free are picked out, but larger fragments, especially those attached to periosteum, are not removed. Exercising suitable retraction on the lips of the wound, first in one direction and then in another, take a final look round to see that no nook or cranny has escaped attention. Then drench the wound with tincture of iodine or pure dettol.
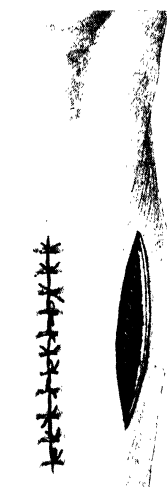
Should the Wound be Sutured ?

Naturally, much discrimination must be used, but given a recent wound with no gross contamination, after thorough excision and disinfection, I have been so well pleased with primary closure that I feel inclined to recommend it. Nevertheless, it must be emphasized

that *the present tendency is to leave the wound open*, and there is much
to be said in its favour. If primary closure is considered desirable,
but it is found that the wound
edges can be approximated only
with difficulty, lateral incisions are
made (*Fig.* 592). This at once
permits the wound to be sutured
without the slightest tension. It
is a method which can be recom-
mended, and it has the advantage of
providing drainage without leaving
bone exposed.

Extension.— Extension is ap-
plied either by adhesive plaster, or,
what is most efficient, some form
of transfixion pin.

Skeletal traction applied by
transfixing a bone some distance
from the site of fracture is
employed more than formerly.
Properly carried out the method is
free from danger and it allows most
thorough extension to be applied
to the limb. Steinmann's pin has
largely given place to Kirschner's
wire (*Fig.* 593). The latter requires somewhat   plicated and
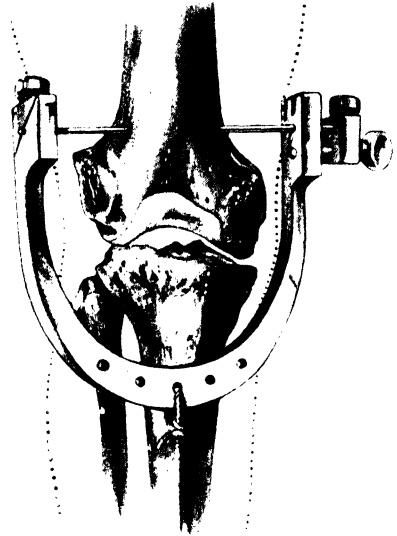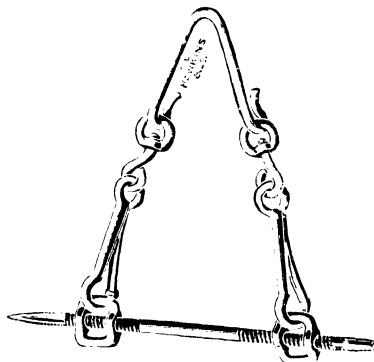
expensive apparatus for its introduction. I have found Whitchurch
Howell's pin (*Fig.* 594) extremely satisfactory; it is very easy to apply
and maintain necessary extension by the 'dog chain' clips.

Fig. 594.— Whitchurch Howe

When a transfixion pin or wire is to be used all instruments em-
ployed in dealing with the open fracture are discarded. *Gloves are
changed and the transfixion is carried out as a fresh operation with sterile
towels and instruments.*

SKELETAL TRACTION BY TRANSFIXION. DETAILS OF TRANSFIXING INDIVIDUAL BONES.

The os calcis is efficient for the majority of fractures below the knee. The
pin is applied three finger-breadths below and behind the external malleolus
(*Fig.* 595) from without inwards at right angles to the bone. Owing to its late
ossification it is a bone which should not be used for skeletal traction below the
age of 14.

Fig. 595. Transfixion of the os calcis.
The arrow indicates the site.

Lower end of Tibia. Can be employed in fracture of the upper end of the tibia,
in purulent arthritis of the knee-joint, and in fracture of the femur. The pin is
applied from within outwards at a point two finger-breadths above the tip of the
internal malleolus. The point of exit should be slightly anterior to the point of
entrance in order to avoid the fibula, which is not penetrated. This site can be
used in children, for the epiphysis lies below the point of transfixion.

Upper end of Tibia. The pin is inserted just below the tibial tubercle and
about two finger-breadths lateral to it, thereby missing the epiphysis. The fibula
is not penetrated (*Fig.* 596).
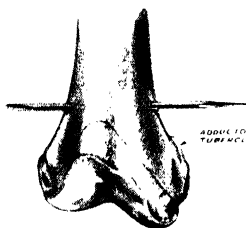
Fig. 597.—Transfixion of the lower end
of the femur.

Fig. 598.—Transfixion of the base of
the olecranon.

Lower end of Femur. A point is chosen on the inner side of the thigh above
the adductor tubercle (*Fig.* 597).

Base of Olecranon. Sometimes fractures of the humerus are better controlled by a pin through the ulna than elsewhere. The arm is flexed to a right angle and a point is chosen at the base of the olecranon just below the head of the radius (*Fig.* 598). Nerves, vessels, and the joint are avoided, and the radius is not penetrated. This site should not be used until after the 15th year.

Splinting.—The splint which will be chosen will be a Thomas's knee-splint in the case of the bones of the leg. In the case of the humerus a Litler Jones' splint will be found the most convenient. For the bones of the forearm a padded straight splint is efficient.

Prophylactic Sera.—Before the patient leaves the theatre anti-tetanic serum is administered, 500 units in the average case, up to 1500 units if there is considerable contamination with road or other dirt. What is quite as important is to inject a prophylactic dose of anti-gas-gangrene serum also. Now that anti-gas-gangrene serum is so readily available, it should be the routine to give 7 c.c. intravenously in the case of compound fractures.

Do not disturb the dressings in any way for seventy-two hours unless the condition of the patient absolutely demands interference.

Some Special Considerations.—

Bone is protruding from the wound. A thin, spiked fragment should be cut off with bone forceps flush with the wound as a first step. If the protruding fragment includes the whole or a large part of the circumference of the shaft, it must be dealt with by cleansing, excising tags of torn periosteum, gentle scraping of exposed cancellous tissue, and swabbing with iodine, again before the wound in general receives attention. Do not attempt to replace the bone until the wound has been excised. If after this has been done the fragment will not remain in position, but tends to prolapse through the wound, as sometimes occurs in oblique fractures, a loop of silver wire passed round the line of fracture will be found useful. About an inch of the twisted ends of the wire is left jutting out of the wound. Eventually, after union has occurred, the wire is removed. It should be emphasized that the loop of wire is only used in very exceptional cases when it is thought that extension will not control a main fragment. In the few cases in which I have used the method it answered admirably. To *plate* immediately an open fracture is a surgical crime (Hey Groves).

The question of immediate amputation arises. A pulped limb with multiple contaminated compound fractures must be treated by a suitable amputation. In cases of comminuted compound fractures, or compound fractures complicated by extensive injuries to soft parts, permission for amputation should be obtained in writing before commencing to operate. Explain to the patient that every effort will be made to save the limb.

There are cases in which it is difficult to decide whether to

amputate or pursue a more conservative course. In the case of a foot which has been crushed and multiple compound fractures of the metatarsal bones sustained, or a contaminated compound fracture involving the ankle-joint, I have found generally that, if amputation was considered, but not performed, after weeks of suffering the patient has had to have an amputation after all. Therefore, in the case of the foot, especially a dirty foot, if the question of amputation arises, carry out amputation rather more readily than in similar circumstances in other situations. After a well-planned amputation there is a definite period of convalescence at the end of which an artificial foot can be fitted to the stump.

Grossly Contaminated Fractures. In an open fracture with a severe wound obviously soiled with road dirt, the initial stages of treatment in no way vary from those already detailed. Débridement of the wound is carried out thoroughly. Contaminated muscle, fascia, and completely loose pieces of bone are removed. Perfect hæmostasis is essential, for the presence of blood and blood-clot in the depths of the wound provides an excellent medium for bacterial growth. The wound is left entirely open and treated by the Carrel-Dakin method.

B. B., aged 9, was run over by a coal cart. Three hours later she was admitted with a large wound of the thigh through which the upper fragment of the fractured femur protruded three inches. The whole wound was thickly plastered with a coagulum of blood and mud. Thorough cleansing and excision of much contaminated muscle was carried out. After washing the protruding bone with spirit the fracture was reduced as well as possible, and as soon as a Thomas's splint with extension had been applied the bone-ends kept their place within the wound, which was left widely open. Carrel-Dakin's tubes were inserted and the wound lightly packed with gauze soaked in Dakin's solution. Subsequently irrigation with Dakin's solution was carried out at regular intervals (*Fig.* 599). Fourteen days later the wound presented a clean appearance, and it was allowed to heal. Two years later the patient was readmitted with a bone abscess at the site of the fracture. A sequestrum was removed and pus evacuated. When seen several months later she was in good health and walked well.

Carrel-Dakin Treatment of an Infected Compound Fracture.— Unless the sister-in-charge has had special experience in the method, every detail of the Carrel-Dakin treatment should be superintended by the surgeon himself. I have often found that this method is not popular with the nursing staff, probably because it entails a good deal of work. The skin around the wound must be protected from the commencement, or else it soon becomes inflamed by the irritating action of Dakin's solution. Sterile gauze impregnated with vaseline is the best material for protecting the skin. Of the many patterns of distributors the one illustrated in *Fig.* 600 is the most useful. If

four distributing tubes are too many, one or more may be occluded by a ligature. The distributing tubes are inserted into the wound with care and thought. One is tucked under the bone, one is placed

Fig. 599. Compound fracture of the femur with gross contamination. Irrigation by the Carrel-Dakin method.

in the superior end of the wound, and so on. The tubes are kept in place by gauze soaked in Dakin's solution. *No bandage is used.* A large piece of Gamgee tissue lined by four layers of gauze is made
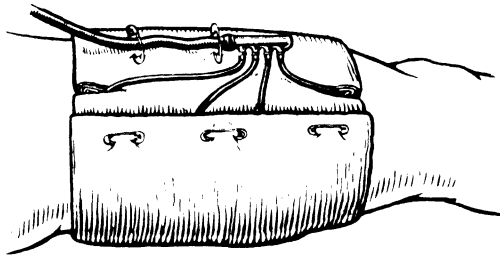
Fig. 600. Position of the distributing tube on the surface of the dressing. The conducting tubes penetrate the dressing, either at the end of the layer of cotton-wool and gauze overlaps, or through windows cut with scissors.

(*After Carrel and Dehelly.*)

to encircle the limb, and is kept in place by safety-pins. The distributing tubes are brought out at convenient spots (*Fig.* 600), cuts being made to accommodate them in the Gamgee tissue. The conducting tube and glass distributor are kept in place with safety-pins

(*Fig.* 600). Every two or three hours some of the solution is allowed to run into the wound (*Fig.* 601). The dressing itself is changed every twenty-four hours until the wound is found to be sweet, when the period may be lengthened to forty-eight hours.

On several occasions I have employed a watery solution of flavine instead of Dakin's solution in the Carrel apparatus, and as far as my observations have gone it has proved satisfactory. The non-irritating character of flavine simplifies nursing.
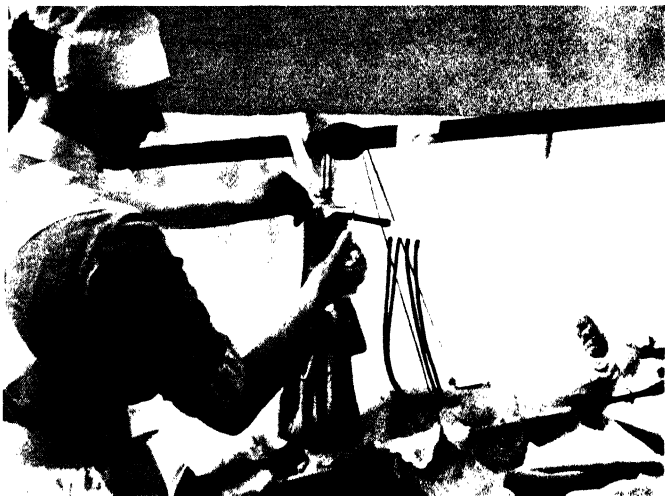
Fig. 601.—Compound fracture of the tibia with contamination, treated by Carrel-Dakin's method. The limb has been placed in a plaster with a large window.

Treatment of some Complications of Compound Fractures.—By prompt and thorough operative treatment of the wound complications are minimized.

Tetanus (*see* p. 687).—The routine prophylactic dose of antitetanic serum has practically eliminated this complication.

Gas Gangrene (*see* p. 644) rarely develops if a dose of anti-gas-gangrene serum is injected at the time of the original operation. If it does so the disease runs a milder course.

Acute Pyogenic Infection of the Wound.—Mild wound infections are treated by removal of the stitches, if stitches have been used, and a flavine compress. More severe acute infections require treatment by Carrel's technique. Virulent infections threatening life may call for amputation. If the question of amputation arises it is advisable to hold a consultation with a colleague.

Chronic Infections.—Winnett Orr's method is eminently suited to this type of case, and the following details are recorded by Professor Hey Groves.

Alfred S., aged 55, suffered from an open fracture of the right tibia and fibula. He was treated by immediate toilet of the wound, which was sutured. The suturing broke down and chronic suppuration ensued. After two months his condition had not undergone much change, and the X-ray showed necrosis of both fragments of the tibia. The patient was in this condition when Dr. Orr saw him and operated upon him. He had already a pin through the os calcis. By means of this the foot was held firmly in the foot-piece of a Hawley's table and sufficient traction applied to pull the leg to a little more than its normal length.

Operation. The wound, which before treatment had the appearance shown in *Fig.* 602, was excised and curetted. The overlapping bone fragments were chiselled away so as to leave a funnel-shaped cavity leading
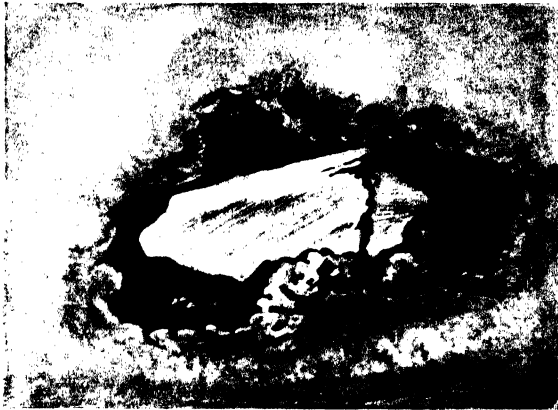
602. Condition of wound previous to Winnett Orr treatment.
(*Figs.* 602–604 *by kind permission of the* ' *British Journal of Surgery* '

down to the deep surface of the tibia. A few small necrosed fragments were removed. Although the leg had been drawn out rather more than its full length a considerable lateral displacement still persisted. This was corrected, and maintained by means of a long transfixion pin which emerged obliquely from the front of the wound. The wound, which had bled freely, was packed first with dry gauze, then with iodine, and after with spirit. Bleeding was thus controlled, and into the dry cavity gauze impregnated with vaseline was packed firmly until it reached the surface. Over the surface another vaseline pad was placed and then a thin layer of cotton wool. A long transfixion pin was passed through the crest of the tibia just below the tubercle. A plaster case was put on so as to include the three transfixion pins and extending to the lower third of the thigh. After the first week the plaster, which was deeply stained with blood (*Fig.* 603), became rather odorous, and this continued until it was removed. The smell was not very objectionable, because the man was on an open-air balcony.

Eight weeks later the plaster was removed. The condition of the limb was very remarkable. There was a small healthy granulating wound on which were a few minute bone fragments (*Fig.* 604). The limb was resterilized, covered with a vaseline pad, and again put up in plaster, the patient being allowed to walk on crutches. X rays showed that union had taken place.

Fig. 603.— The limb in plaster, which was not changed for eight weeks.

D. A//ERS,

Fig. 604.— Appearance of the wound eight weeks after treatment on removal of the first dressing.

ACUTE PERIOSTEOMYELITIS

"Acute osteomyelitis is a surgical emergency as acute as any emergency known to surgery—minutes count."—(*R. A. Cutting.*)

Although there are many striking differences of opinion as regards the technique of the treatment and the after-treatment of acute osteomyelitis, all surgeons are agreed upon the extreme urgency of drainage by operation. The difficulties connected with osteomyelitis are those of diagnosis and judgement rather than those of operative technique. For instance, in a delirious child it may be impossible to detect which bone is affected. Should the choice lie between two bones, and exploration of the first is not rewarded, the wound must be closed after swabbing it lightly with B.I.P.P. before undertaking the exposure of the second.

The question of the advisability of amputation in a young subject is always a grave one, but in these days of excellent artificial lower limbs the responsibility is perhaps not so onerous as in times
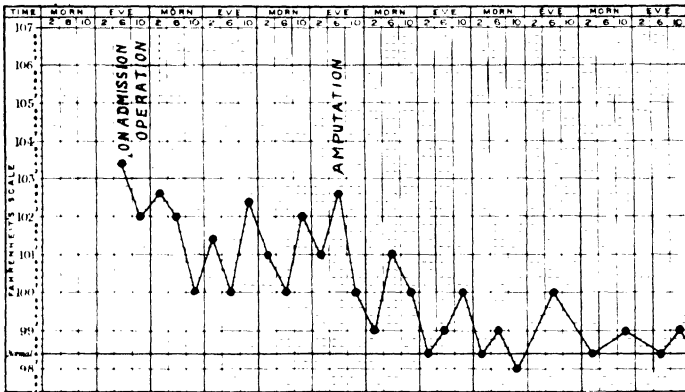
to osteomyelitis of the tibia involving the ankle-joint, con-
in spite of drainage. Note the improvement after amputation.

past. From time to time one is faced with the problem—Is it possible to save life by sacrificing the limb ? The question seldom arises until days, or sometimes weeks, after the bone has been drained. Sometimes it is gratifying to see how quickly the general condition improves after the diseased member has been removed (*Fig.* 605). Before advising amputation many factors must be taken into consideration, but if possible the limb should be removed before pyæmia has set in.

General Considerations follow the teaching of Professor Fraser of Edinburgh. In all cases the patient is anæsthetized. A tourniquet is employed in disease of the lower third of the femur, the tibia, the fibula, and the bones of the foot and hand ; it is not employed around the humerus for fear of injuring the musculospiral nerve. A specimen

of pus from the bone is collected during the operation and sent for bacteriological examination, with a request for an autogenous vaccine. Every operation for acute osteomyelitis is concluded by an intravenous injection of mercurochrome, and the patient is ordered rectal or continuous intravenous saline as the needs of the case demand. So long as the temperature remains considerably elevated a daily injection of mercurochrome is given. The details set forth in the case of the tibia will apply with equal force to most of the bones, which are considered later.

The Tibia.—The tibia is considered first because it is the bone most frequently affected. The clinical examination will have indicated whether the upper end of the tibia, the lower end, or the whole shaft is diseased. The clinical examination and a little logical reasoning will have singled out those rare examples where the disease is confined to the subperiosteal layer. An incision is made right down to bone over the point of greatest tenderness (*Fig.* 606). In most cases pus will be found beneath the periosteum. To commence with the incision is a short one, but is enlarged according to the amount of the periosteum which is stripped up. Exceptionally it is mischievous to open the bone, and thus carry the infection into the medulla ; such cases are of the greatest rarity. Subperiosteal abscess is usually seen in older children and adults, and the circumscribed nature of the infection should be evident before operation. I believe that the medulla should always be displayed unless the operator feels quite certain before commencing the operation that there is no infection within. The bone is opened with a half-inch trephine (*Fig.* 606) ; this causes much less trauma than the chisel and mallet. The disc having been removed, the interior is inspected, but the medulla is not scraped or otherwise interfered with.

Should there be pus within the bone a second trephine hole is made two inches distant. If it is thought desirable, the intervening bridge can be removed with a chisel, but the last step is not often considered necessary. When the whole diaphysis is involved a third trephine hole will be required. The wound is packed lightly with strip gauze soaked in flavine. No skin sutures are used. Professor Fraser recommends dressing the wound with gauze soaked in a solution of acriflavine emulsion 1-1000 with potassium citrate 2 per cent. The citrate solution helps to keep the discharge fluid. Whether to conclude the operation by placing the leg on a back splint, or enclosing it in a light plaster without a window, is a matter of personal preference. So that there will be no regrets I recommend that the plaster be employed only in cases where the temperature is under 102°. Over the packing a copious gauze and wool dressing is applied, and if plaster is employed the limb is encased so as to include the related joints

above and below the site of the lesion. The plaster is left in place
for a fortnight, after which time it is removed under light anæsthesia
and the dressing and the plaster renewed.
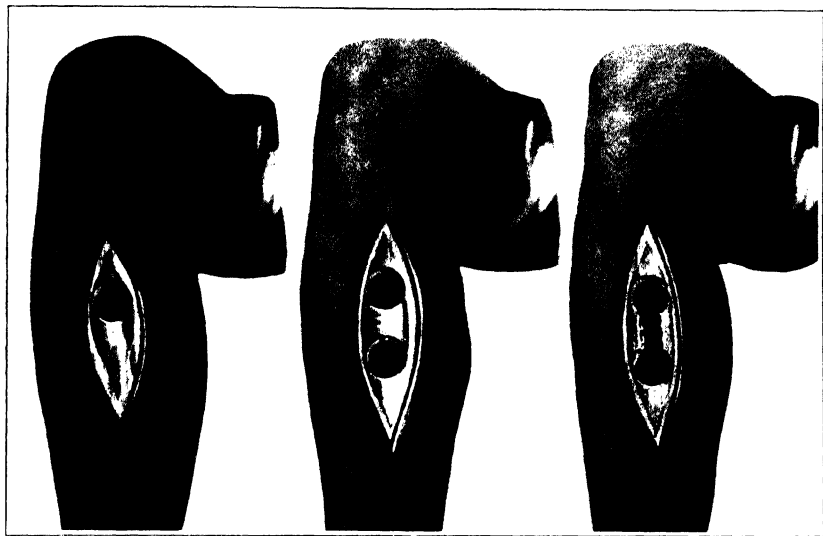
Fig. 606. The periosteum having been incised, a trephine hole is made over
the point of greatest tenderness. In some cases a second, and occasionally a
third, trephine hole will be necessary. If the surgeon so desires, the intervening
bridge between the holes can be removed with a chisel.

The Fibula. As far as the treatment of acute osteomyelitis is
concerned, the fibula, by virtue of its anatomical and functional
peculiarities, stands in a class by itself. It is for the fibula, and for
the fibula alone, that diaphysectomy can be
recommended unhesitatingly. The clean
granulating wound which followed my first
case of osteomyelitis of the fibula treated
by this method emboldened me to try a
primary suture on the next example to
present itself. I have now carried out
diaphysectomy with suture five times. The
wounds have healed by first intention, and
have remained healed -verily a real grati-
fication in a disease like acute osteo-
myelitis !

Fig. 607. Sequestrum re-
moved from sinus which deve-
loped over the upper end of
the incision.

As I knew of a case where the external popliteal nerve had been
divided in removing the diaphysis of the fibula, it came about that
in my first case, in the determination to ensure the integrity of this

nerve, I left a piece of the upper end of the diaphysis behind. Six months later a sequestrum was removed from the bottom of a sinus which developed over the upper end of the incision (*Fig.* 607). The

Fig. 608.—Excising the diaphysis of the fibula. Note Doyen's raspatory above the rib shears.

following method, which is practically fool-proof, has been used in the remaining three cases with great rapidity and satisfaction.

Fig. 609.—Diaphysectomy of the fibula. Condition of the wound three and a half weeks after operation.

After the application of a tourniquet to the thigh, the shaft of the fibula is exposed through an ample incision, the peronei being retracted anteriorly. Using Doyen's raspatory, the periosteum is cleared, and the whole of the diaphysis resected with rib shears, just as though it were a rib. The lower end is divided first, and whilst the upper end is being sectioned with the shears. Doyen's raspatory remains *in situ* around the extreme upper end of the bone, protecting the nerve (*Fig.* 608). As soon as the shaft of the fibula has been removed, its bed is swabbed out with a watery solution of flavine, and the wound closed by interrupted sutures, except for a glove drain in its lower end.

No permanent disability attends the removal of the shaft of the fibula. A light plaster case can be applied as soon as the wound has healed (*Fig.* 609), but this is not essential. The shaft of the fibula slowly regenerates (*Fig.* 610), but long before this the patient is walking normally.

The Femur.—

The Lower End. —An incision is made down to the bone on the outer aspect just above the tendon of the biceps. The femur is exposed, taking care not to open the suprapatellar pouch, which communicates with the knee-joint. The bone is trephined. Before packing the cavity the tourniquet is removed and bleeding points are attended to. In infants the gallows splint (*Fig.* 611) is a convenient method of keeping the limb at rest. In older children and adolescents a straight back-splint is as good as any, as the lateral bars of a Thomas's splint make it rather inconvenient for dressing the wound. In this situation Thomas's splint is not essential.

The Shaft. —It is not advisable to use a tourniquet for fear of hampering the work towards the upper third. An incision is made on the outer side of the thigh, bleeding points being tied as they occur. Excellent as is Henry's muscle-displacing incision for dealing with fractures by the open method, it is not to be recommended in acute osteomyelitis: overlapping muscles form a bar to the exit of

Fig. 610. — Showing regeneration of the fibula after diaphysectomy; X-ray taken eight months after operation.

pus. The incision must be deepened right through the muscles on the outer side. When bone is displayed by suitable retraction the periosteum is incised and lifted up by a periosteal elevator. The length of the incision in the periosteum depends upon the extent of

disease beneath it. The bone is trephined; usually one trephine hole suffices, but as in the case of the tibia (q.v.) one is governed by what is found within. A Thomas's splint is advisable. Extension will help to keep the limb at rest.

The Upper End.—Osteomyelitis of the upper end of the femur is difficult to diagnose. In a large number of cases the condition of the patient is grave, and delirium makes correct diagnosis even more obscure. In the case of the neck of the femur, acute arthritis of the hip-joint (*see* p. 600) is a frequent accompaniment. In dealing with

Fig. 611. Infant with acute osteomyelitis of the lower end of the femur treated in a gallows splint.

osteomyelitis of the neck I have had considerable satisfaction in trephining the great trochanter through a short incision over this structure. With a closed hæmostat the cancellous bone is readily penetrated towards the head. In one instance an appreciable amount of pus was evacuated by this route.

The Tarsal Bones.—Osteomyelitis of the tarsus, as opposed to the metatarsus, should be looked upon with great circumspection. The diagnosis is difficult and the treatment unsatisfactory. It is usually impossible to tell which bone is affected unless it is the os calcis, which is a satisfactory bone to drain. Osteomyelitis of the other tarsal bones may be confused with acute arthritis of the ankle-joint, which is sometimes present as well. In osteomyelitis of

the tarsus a dorsal incision over the point of greatest tenderness may evacuate pus, but this is not enough. In one of my patients, a man of 25, a considerable amount of pus was evacuated by a dorsal incision, but the patient died of septicæmia, for procrastination delayed amputation until it was too late. Since this case I have treated a small child with osteomyelitis of the tarsus by a dorsal incision supplemented by a plantar incision, together with through - and - through drainage. In this instance drainage answered admirably; but in two other cases, as the temperature did not subside within forty-eight hours, the foot was amputated, leaving a seven-inch stump. I carefully dissected the tarsal bones in one of these amputated feet; the intertarsal joints were full of pus. It is impossible to drain all these joints, hence the unfavourable outlook.

Fig. 612. Acute ost   of the clavicle. Untreated for five days. The skin is becoming eroded.

The Clavicle (*Fig.* 612).
This bone is easily displayed by an incision along its subcutaneous border. It is not always necessary to expose the medulla, but usually it is advisable to make a small hole with a hand-drill. A complete cast of the clavicle is eventually formed as a sequestrum. After this has been removed the end-result is satisfactory.

The Scapula.—Make an incision over the spinous process, enlarging it downwards or upwards by a T-shaped extension if necessary. In two cases where this bone was affected pus was found under the periosteum in the infraspinous fossa. Tube drainage was employed.

The Humerus.—One should bear in mind the relationship of the musculospiral nerve, and preserve it at all costs. Below the insertion of the deltoid the humerus is readily displayed by an incision on the outer side of the biceps muscle. Above the insertion of the deltoid the interval between the deltoid and the biceps is chosen. Once the bone has been displayed the technique described for the tibia is employed. If it is available, Litler Jones's arm-splint is very efficient.

The Radius.—

The lower end of the bone is the part usually diseased. An incision over the radial side of the dorsum is made. The tendons of the extensors are in the way; suture them to the ulnar side of the

Fig. 613.— Acute omyelitis of the radius treated in the manner described in the text. Good as to the bone is obtained, as can be seen by the packing being inserted into the bone. The end-result in this case was very good.

deeper planes of the wound with loops of catgut (*Fig. 613*). Trephine the bone in the usual way. A Jones's cock-up splint or a Carr splint is employed.

The upper end of the radius is more difficult to approach, and the posterior interosseous nerve is a constant source of danger.
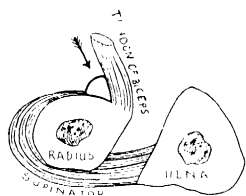
Fig. 614.— Showing the cut made through the bicipital bursa. The knife is kept close to the outer face of the biceps tendon. The supinator is then peeled off the radius. The arrow shows the direction of the cut through the bursa.
(*A. K. Henry.*)

Henry's method of approach should be followed. Make an anterior incision over the line of the bone. Expose the tendon of the biceps by dividing the deep fascia on its outer side. Continue the division of the fascia throughout the wound with blunt-nosed scissors. Pass the finger along the outer side of the tendon of the biceps until it meets the resistance of the recurrent vascular loop. Hook this up and divide it between ligatures. Retract the muscles widely and expose the supinator brevis. Return to the biceps tendon. Keep the knife close to its outer side and cut down upon the tuberosity of the radius (*Fig. 614*). This divides the bicipital bursa, and the knife strikes the tuberosity of the radius where it lies in a bay formed by the edge of the supinator brevis. With a rugine peel the supinator off the bone. The muscle is turned outwards, carrying within its substance the posterior interosseous nerve. In

such a deep-seated bone, where drainage is unsatisfactory, it would appear that in cases of extensive disease of the upper half of the radius that portion lying above the insertion of the pronator radii teres might well be excised.

The Ulna.—The ulna is comparable to the tibia, for it has a subcutaneous surface throughout its length. Consequently it is technically a simple bone to drain.

The Carpal Bones. Osteomyelitis of the carpus is rare, and apparently not so lethal as that of the tarsus. Personally, I have dealt with only one case. A dorsal incision was made and pus was evacuated. The resulting sinus discharged for months, and all the carpal bones with the exception of the pisiform became rarefied. At the end of eighteen months the sinus closed, and there was permanent disability by reason of the patient's being unable to make a fist.

The Metacarpal and Metatarsal Bones.—The metacarpals and metatarsals offer no difficulty. An incision is made exposing the dorsal surface, which is trephined in necessary cases with a bradawl or hand-drill.

Fig. 615.—Exuberant granulation tissue round a sinus in a case of osteomyelitis of the sternum.

The Sternum.—A short incision over the point of greatest tenderness is made. If the trephine is used, be careful not to trephine too

deeply. *Fig.* 615 shows a case of osteomyelitis of the manubrium six weeks after the emergency operation. The excessive proliferation of granulation tissue is remarkable.

The First Rib.—Osteomyelitis of the first rib is very difficult or impossible to diagnose. In an example which was seen on the tenth day of the disease, there was a brawny swelling below the sterno-clavicular joint. The exact source of the trouble was revealed by X rays at a later date. Ribs in the more superficial series require no special mention.

The Spine.—Any part of the spine may be involved, but the region most often attacked is the upper lumbar. All that is necessary is a suitable incision to give vent to the pus and thus save the patient from pyæmia or meningitis. The overwhelming obstacle is supreme difficulty in diagnosis. Acquaintance with osteomyelitis has generally been made in the post-mortem room. One of my cases developed a psoas abscess which was drained, but the child died. Another developed a retropharyngeal abscess which was also drained, with happy results. A third, a woman of 28, was operated upon for what was thought to be a perinephric abscess ; after a long convalescence she also recovered. No precise instructions are possible for osteomyelitis of the spine.

The Os Innominatum.—Usually the crest of the ilium or the pubic bone is involved. Simple incision gives satisfactory results, but the resulting sinuses are very prone to become chronic.

BRODIE'S ABSCESS

Brodie's abscess is seldom an urgent condition. A sudden flare up of a bone abscess may necessitate immediate drainage. In the case of the tibia a *transverse* incision over that portion of the bone containing the abscess will be found to give excellent exposure. The bone is trephined, after which the abscess cavity is mopped dry and packed.

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CHAPTER XXXV

JOINTS

DISLOCATIONS

The Hip-joint (*Fig.* 616).—

Posterior Dislocations (Dorsal and Sciatic).—Place a mattress on the floor, and upon this lay the fully anæsthetized patient. Get an assistant to fix the pelvis firmly by placing his hands on the anterior superior iliac spines and exerting pressure towards the mattress. Then : (1) Flex the thigh ; (2) Lift, as if trying to lift the patient (*Fig.* 617). If obstruction is experienced, rotate inwards, and lift again. If not successful, rotate outwards and lift once more. Sometimes the head seems to come upon the edge of the acetabulum but fails to slip over it. If so, gently extend as well as lift.

Anterior Dislocations (Obturator and Pubic).—As before, have the anæsthetized patient upon a mattress on the floor. Flex strongly, then *abduct* the thigh. This will bring the head near its point of exit. An assistant places the base of his palm on the head in the groin and pushes the head outwards and backwards. Adduction now makes the assistant's hand a fulcrum and levers the head into position (*Fig.* 618).

Fig. 616. —Dislocations of the hip-joint.

After-treatment. The patient should remain in bed for three weeks and massage should be prescribed. Alternatively, a hip plaster may be applied at the end of a week and the patient allowed to get about on crutches.

The Elbow-joint.—Reduction of a backward dislocation of the elbow is usually readily accomplished by the method shown in *Fig.* 619. After being reduced, the arm is put up in full flexion for three days. It should be kept nearly fully flexed for three weeks by a

Fig. 617.   Method of reducing a posterior dislocation of the hip.

Fig. 618.—Method of reducing an anterior dislocation of the hip.

wrist sling short up under the chin (Sir Robert Jones). The frequent occurrence of myositis ossificans following the accident is the reason for this somewhat prolonged period of rest.

The Shoulder-joint (*Fig.* 620).

Anæsthesia. In a recent dislocation it is not essential to anæsthetize the patient. The comparative frequency of deaths under anæsthesia during the reduction of dislocations of the shoulder belonged to the time when whiffs of chloroform were given. With full anæsthesia there is no peculiar danger. Evipan is very useful; in my opinion it is the ideal anæsthetic for use when reducing this and other dislocations.
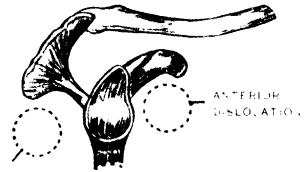
Anterior Dislocation. Particularly when reducing a recent dislocation without anæsthesia, *Kocher's method* is rightly popular, but it is often imperfectly understood and incorrectly applied. Kocher's method depends upon tiring out the subscapularis until that muscle relaxes. If this is borne in mind the rationale is clear. If an anæsthetic is not

Fig. 620. Dislocations of the shoulder-joint.

used, the patient is seated. The surgeon places his hand on the flexed elbow and presses the elbow gently to the patient's side. With the

other hand he grasps the wrist. Slowly, but firmly, the arm is externally rotated, using the forearm as a lever (*Fig.* 621 A). In a muscular man it may take several minutes before the subscapularis ceases to resist. The relaxation of the muscle is usually sudden, but there is no need to hurry the subsequent manipulations. The point of the elbow is carried towards the umbilicus (*Fig.* 621 B). During this movement reduction is often completed. The third movement is of subsidiary importance. It is internal rotation : the hand is made to touch the opposite shoulder. To summarize : (1) Slow external rotation until the subscapularis relaxes ; (2) Adduction —the elbow is carried towards the umbilicus ; (3) Internal rotation — the hand is made to touch the opposite shoulder.

A   B
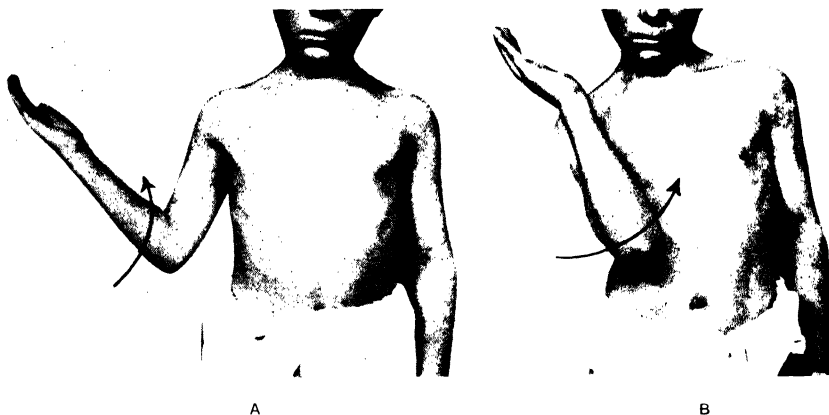
Fig. 621.—Kocher's method of reducing a dislocation of the shoulder. A, External rotation should be slowly performed in order to tire out the subscapularis. B, Adduction ; the elbow is carried to the umbilicus.

Occasionally this method fails, even with anæsthesia. An *alternative method* is as follows : Place a roller towel around the patient's thorax by passing the feet through a loop of the towel and threading it up the trunk until it lies around the thorax. The towel is used to steady the patient and is a means of counter-extension by an assistant. A long piece of broad flannel bandage is now passed round the axilla of the affected side, and a second assistant pulls on this in the direction shown in *Fig.* 622, thus fixing the scapula. The surgeon first exercises traction on the arm at right angles to the body. Keeping up this traction he then carries the arm towards the patient's side. If unsuccessful, this manœuvre is repeated, using the left hand to lever the head of the bone into the glenoid cavity.

Posterior Dislocation.—Backward dislocation is rare. Reduction is accomplished by : (1) Traction on the arm to tire out the muscles ;

(2) Adduction, to clear the head of the humerus from the posterior margin of the glenoid ; (3) Raising the arm to make the head pass towards the lower margin of the glenoid ; (4) Lowering the arm to allow the head to return into its socket by the path by which it left.

Luxatio Erecta. —Luxatio erecta is exceedingly rare. In the only example which I have been called upon to treat, the patient, who walked into hospital with his arm above his head, was anæsthetized

Fig. 622. Alternative method of reducing a dislocated shoulder. (1) Assistant exerting counter-traction with a roller towel round the thorax ; (2) Second assistant exercising pressure on the head of the bone towards the glenoid cavity by means of a length of flannel bandage ; (3) Surgeon, who after exercising traction in the direction shown, walks towards the patient's hip still pulling on the arm.

and the dislocation reduced itself under anæsthesia. In the ordinary way upward traction of the arm would be used to reduce the dislocation.

After-treatment. Bandage the arm to the side for three days. After this the patient wears a sling and attends for massage. Full abduction of the arm should be guarded against in the early stages. It is this movement which tends to produce re-dislocation through the torn capsule.

The Metacarpo-phalangeal Joint of the Thumb. — The difficulties of reduction of this dislocation have been overstated. The prevalent opinion is that the head of the metacarpal becomes hopelessly entangled amongst the flexor muscles of the thumb.

Traction is useless. Hyperextend the thumb and push the base of the phalanx over the head of the metacarpal. After reduction has been completed the best splint is the horseshoe-shaped one described by Sir Robert Jones. If this is not procurable, a Gooch splint will meet the case.

Displaced Internal Semilunar Cartilage. — Under gas anæsthesia flex the leg on the thigh and the thigh on the trunk. Rotate outwards and abduct the leg to open the inner side of the knee-joint. Then rapidly rotate inwards and extend. Sir Robert Jones gives the following instructions for reducing the displacement without an anæsthetic : " Ask the patient to kick his leg into full extension, counting ' one, two, three, kick.' On the word ' kick ' the patient violently extends his thigh and leg, while at the same instance the surgeon rotates inwards and helps extension by pulling on the foot."

PENETRATING WOUNDS

Penetrating wounds of joints are mostly confined to the knee and ankle, and for this reason attention will be directed to these particular joints.

The Knee-joint.—The general method of treatment is indicated in the following case :—

A carter was driving his van, when the horse bolted. He was thrown to the ground and dragged. He thought that the wheel of the cart went over his knee. There was a large wound over the inner half of the patella, exposing the bone and communicating freely with the interior of the knee-joint. The whole of the wound was grossly contaminated with road dirt.

The skin was purified and the wound edges were excised most thoroughly. A small incision into the joint was made from the outer side of the patella where the skin was intact, and into this was inserted the beak of a nozzle connected with a tube and funnel. The interior of the joint was irrigated with two or three pints of flavine, the fluid flowing out by way of the penetrating wound. As the fluid was flowing, the deeper planes of the wound (e.g., the torn synovial fringes) were trimmed. The wound edges were then lightly approximated with silkworm gut. The limb was placed in a Thomas's splint and a 14-lb. extension applied. Antitetanic serum was given. The wound healed by first intention, and perfect function followed.

When excising the wound, pare away the skin edges, put aside the instruments which are used for this, and use fresh instruments for the synovial membrane. If this is done, the surgeon is guiltless of carrying infection into the deeper planes of the wound.

Should suppuration follow, the treatment follows the lines laid down below in the section on purulent arthritis of the knee-joint. In

very severe suppuration it may be necessary to turn back a flap containing the patella after having divided the ligamentum patellæ, and irrigate the joint by the Carrel-Dakin method. After the joint is clean the flap is sutured into position. At the best, ankylosis is sure to follow.
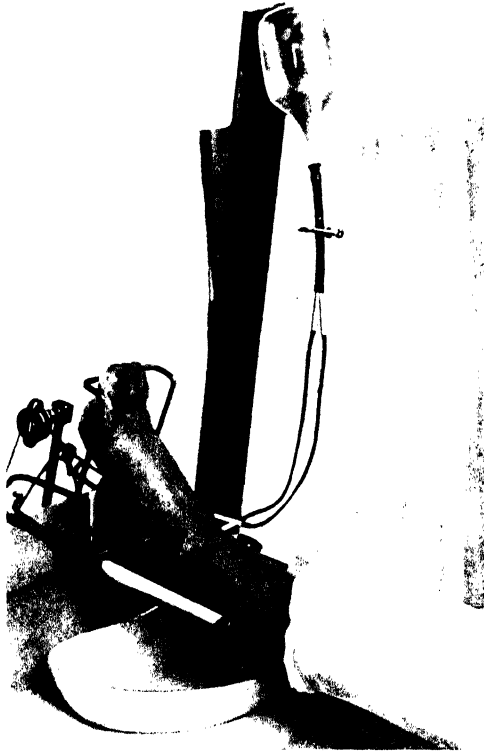
Fig. 623. Compound fracture involving the ankle-joint, treated I Carrel Dakin method. Amputation was eventually performed.

The Ankle-joint. Open wounds of the ankle-joint, when they occur in civil practice, are usually accompanied by a compound fracture of one or several of the bones entering into the joint. If the foot is crushed also and lacerated unquestionably it is better to amputate, giving the patient a seven-inch stump. I am inclined to amputate in compound fractures involving the ankle-joint where there is much contamination of the wound. *Fig. 623* shows a case in which no effort was spared to save the foot. The wound was excised carefully, extension applied by a pin placed through the os

calcis, and Carrel-Dakin irrigation employed. After weeks of suffering amputation had to be performed after all. The stump healed by first intention. A year later I saw the patient walking in the street with his artificial foot, and it was impossible to detect a limp. He was back at work as a warehouseman.

ACUTE SUPPURATIVE ARTHRITIS

The diagnosis of acute suppurative arthritis is often difficult. When in doubt the joint should be needled. On occasions the differential diagnosis between acute osteomyelitis and acute suppurative arthritis is perplexing. After the limb has been prepared for operation and the patient anæsthetized there is no objection to aspirating the joint as a preliminary measure. Nevertheless, it must be emphasized that the withdrawal of slightly turbid fluid should not deter one from the exploration of the bone. The demonstration of pus beneath the periosteum is the signal to desist from further interference with the joint, at any rate for several days. In all probability the associated joint condition is 'sympathetic arthritis' and will abate if the bone is drained.

In setting forth the methods of treating acute suppurative arthritis it has been considered best to deal with each principal individual joint.

The Hip-joint.—The hip-joint is the most difficult joint in which to diagnose acute suppurative arthritis, and probably the most difficult joint to treat.

A woman aged 41 was admitted to the medical side in a delirious condition. The left hip-joint was slightly flexed and externally rotated, and more especially on this account I was asked to see her. She was a fat woman, and it was difficult to make anything out except that there was some slight limitation of movement in the left hip. An X-ray examination was negative and a leucocyte count was normal. Under an anæsthetic I put a hollow needle into the joint. Pus welled up. The joint was drained in the manner which will be described presently. After a long convalescence she recovered with bony ankylosis of the joint.

Needling the Joint.—Bisect a line joining the anterior superior iliac spine with the symphysis pubis by another line drawn at right angles to it. On the latter line, about 1½ in. below Poupart's ligament, lies the head of the femur. The femoral artery lies well to the inner side of the aforesaid bisecting line. With a finger of the left hand locating the femoral artery drive a wide-bore needle towards the head of the femur, giving the needle a slightly upward tilt. It is difficult to know when a needle is within the hip-joint, and it may be necessary to manipulate the point of the needle several times before a satisfactory entry is assured. Do not be in a hurry to remove the needle; it sometimes takes a moment for thick pus to well up. I have found it

more satisfactory to rely on a plain hollow needle rather than a needle connected with an aspirating syringe. The needle by itself can be manipulated with greater delicacy, and if there is pus within the joint the intra-articular pressure is sufficient to force this pus into the stem of the needle.

If pus has been found, leave the needle in position and consider the advisability of draining the joint by the open method. All cases of acute purulent arthritis of the hip-joint should be drained—with, I believe, one possible exception, pneumococcal arthritis: when the patient has, or is convalescent from, lobar pneumonia, and the general signs indicate that he has developed a certain immunity to the organism, aspiration, together with heavy extension, is justifiable.

Drainage. For the last five cases of purulent arthritis of the hip-joint I have employed the approach described by Hey Groves, and this method will be described, for it appears to me to be the most satisfactory. The incision is 6 to 8 in. in length, and its centre is at the anterior superior iliac spine. The upper half of the incision runs along the crest of the ilium and the lower half along the line of the sartorius. The incision is deepened, the fascia divided, and the muscles separated from the outer surfaces of the ilium, the tensor fasciæ femoris being separated from the sartorius. By this means the anterior *inferior* spine is exposed, with the origin of the rectus femoris muscle. The latter is divided, and the front and outer surfaces of the hip-joint are exposed. The capsule, which is from a quarter to half an inch in thickness, is divided by an incision parallel to the neck of the femur. Once the hip-joint has been opened and pus evacuated, the incision into the capsule is enlarged somewhat by a short transverse cut outwards. A tube is inserted into the joint and the capsule loosely approximated about the catheter. The skin is also approximated about the tube and a glove drain inserted in the lower end of the wound. An injection of mercurochrome is given intravenously at the conclusion of the operation. An anchor dressing is sewn over the upper half of the incision, and a Thomas's splint applied to the limb. By means of a stirrup, the limbs of which extend to the middle of the thigh, 15 lb. of extension are applied. The interior of the joint is filled with flavine by means of the catheter. In one case the tube was connected to a suction apparatus; this, if available, is a good means of removing the pus.

Bony ankylosis of the hip-joint must be expected in nearly all cases, but this is a matter of secondary importance in such a fatal condition as purulent arthritis of the hip.

The Knee-joint.

Aspirating the Joint. A rather fine needle connected with an aspirating syringe is used. The inner and lower aspect of the patella

is chosen for the puncture, and the point of the needle is directed
backwards, outwards, and slightly upwards. The fluid removed is
sent for bacteriological examination, but its macroscopic characters
are carefully noted, and it is largely on these that we base our treat-
ment, which must be carried out long before the bacteriological report
is returned. It is well to bear in mind constantly that there is often
an effusion into the joint in cases of acute osteomyelitis—the so-called
'sympathetic arthritis'. In these cases the joint should be left severely
alone and the bone attended to.

1. *The pus withdrawn is thin (i.e., semipurulent fluid).*— Aspirate
the knee-joint completely and insert through the hollow needle by
means of the aspirating syringe enough flavine to distend the joint
loosely. Apply heavy extension (15 lb. for a man) by means of an
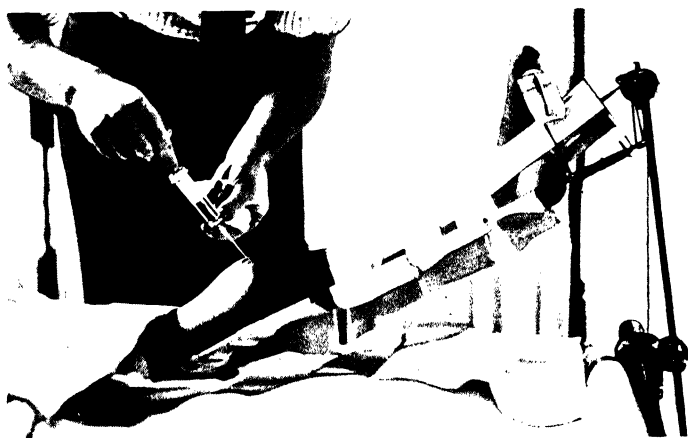
the knee-joint in a case

adhesive plaster stirrup, and keep the limb at rest in a Thomas's splint.
The extension keeps the joint surfaces apart and helps very materially
to prevent ankylosis. In forty-eight hours' time the joint is again
aspirated and flavine again instilled. No anaesthetic is necessary.
Fig. 624 shows the operation in progress. After this, do not repeat
the aspiration unless the temperature and local signs indicate that the
suppurative process is still active. In one case I aspirated and
injected five times, and the end-result was a perfectly movable joint.
The extension is maintained until the inflammation has subsided,
usually a matter of ten to fourteen days. The weight is then removed,
but it is wise to keep the strapping and the stirrup on, for, should the
inflammation light up, the extension may be reapplied immediately.
If after twenty-four hours without extension the signs of renewed

inflammation are absent, massage and movement are commenced. Usually one may anticipate a good end-result.

2. *The pus withdrawn is thick, or contains flakes of opaque purulent material. The general condition of the patient shows a very marked reaction.*—A general anæsthetic is given. After most thoroughly sterilizing the skin, an incision is made on the inner aspect of the patella down to the capsule of the knee-joint, which is opened. A small counter-incision is then made on the outer aspect of the patella, and through this the nozzle of a funnel and tube irrigator is passed into the joint (*Fig.* 625). The synovial cavity is now washed out with about two pints of flavine. The joint is sewn up. For this I avoid catgut and pass deep through-and-through silkworm-gut sutures. The stab-wound on the outer side is closed by a single stitch. Heavy extension is applied.

The after-treatment is the same as described in the foregoing section, but the limb will have to be kept at rest for a somewhat longer period.

If in doubt which course to pursue, commence with aspiration and injection. Reserve washing out the joint for frankly purulent cases.

-joint with

The treatment of purulent arthritis secondary to an osteomyelitis of the bones entering into the formation of the joint is very disappointing. The majority of my cases have eventually come to amputation, which, had it been performed earlier, would have prevented months of suffering. In these days of excellent artificial limbs we are more than justified in advising early amputation in cases where the outlook is poor.

In the following case of purulent arthritis of the knee-joint extending from osteomyelitis of the tibia, a successful result was achieved without amputation.

A little girl had acute osteomyelitis of the tibia, which had been treated by trephining the upper end of the bone. At the end of the first week it was evident that there was pus in the knee, and this was confirmed by aspiration. On injecting some flavine into the joint I noticed that it ran out of the hole in the tibia. A de Pezzer catheter was introduced into the suprapatellar pouch (*Fig.* 626), and extension was applied to the limb. The joint was irrigated with flavine by way of the catheter three times a day for a week, the irrigation passing out through the tibial wound, which quickly took on a healthy appearance. The catheter was then removed, the wound healed well, and there was very good movement in the knee-joint.

Fig. 626. A de Pezzer catheter introduced into the suprapatellar pouch was used to irrigate the knee-joint in the case described in the text.

The Ankle-joint.—Purulent arthritis of the ankle-joint is rather rare. It may be confused with acute osteomyelitis of the tarsal bones.

Needling.—The exact line of the joint is ascertained by palpation, and when possible by movement of the foot on the tibia. Choosing a point on the line of the joint just internal to the external malleolus (*Fig.* 627), the needle is directed backwards and slightly downwards so as to strike the interval between the tibia and the astragalus.

Drainage.—In a case of pneumococcal arthritis I have seen the aspirating needle, which was a large one, left *in situ* for three days, and the joint was moved each day to expedite evacuation of pus ; the method answered admirably. Such a plan should only be entertained when the patient has a good immunity to the infecting
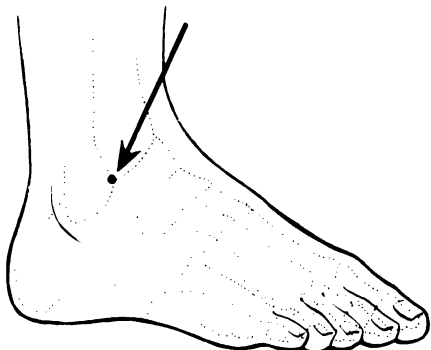
Fig. 627. Showing the point at which the needle is entered in aspirating the ankle-joint.

organism, which is a common feature in pneumococcal joint infections. The usual incision recommended for draining the ankle is an anterior one passing between the tendons on the anterior surface of the joint. This approach to the interior of the joint, for purposes of drainage, leaves something to be desired. In one case a counter-incision was

made by passing a probe into the joint through the anterior incision and making its blunt extremity protrude beneath the skin on the postero-internal aspect of the joint. This counter-incision allowed irrigation of the joint with flavine, and subsequently provided dependent drainage. In another case I stumbled across what appears to be a satisfactory method; at least it proved efficient in the solitary instance in which it was employed. A transverse incision was made over the most prominent part of the external malleolus. The malleolus was trephined with a half-inch trephine (*Fig.* 628). B.I.P.P. was smeared on to the teeth of the trephine in order to carry an antiseptic into the interstices of the bone. The disc does not come away in a single piece; this gives an opportunity for introducing more B.I.P.P. into the walls of the bony tract. After the fibula has been trephined completely a surprisingly good view of the interior of the joint is

Fig. 628. -Purulent arthritis of the ankle-joint. Approach to the joint by trephining the external malleolus.

obtained. In my case pus ran out freely. The limb was placed on a back splint and the wound syringed out with flavine, and it healed gradually, with fair movement in the joint.

The Shoulder-joint. Acute suppurative arthritis is simulated to some degree by suppuration in the subacromial bursa. On occasions the bursa communicates with the joint.

Needling.—Needling the shoulder-joint is a comparatively simple matter. A point is chosen between the pectoralis major and the deltoid. If the subacromial bursa is enlarged, naturally the needle will be introduced at this point and the joint proper studiously avoided.

Drainage. An incision between the pectoralis major and the deltoid will lead down to the capsule, which is opened. A self-retaining catheter may be passed into the subglenoid pouch and the capsule loosely approximated around the catheter. The arm should be placed at right angles to the body, preferably in a Litler Jones splint, which is

particularly valuable, for it allows extension to be applied to the arm, and keeps the joint in the best position for ankylosis should it occur.

The Elbow-joint.

Needling. —Flex the elbow to a right angle. After ascertaining the position of the radial head, introduce the needle posteriorly to the outer side of the olecranon.

Drainage. —A straight posterior incision somewhat to the outer side of the olecranon leads right down to the joint capsule and has the advantage of avoiding important structures.

I have treated two cases of primary purulent arthritis of the elbow-joint in this way. The first case was that of a baby recovering from chicken-pox. The second was a girl of 18 in whom no primary focus was discovered. Extension was provided by traction on the flexed forearm with the limb on a Robert Jones splint. Both cases made a good recovery.

EXTENSOR
INDICIS

EXTENSOR
LONGUS
POLLICIS
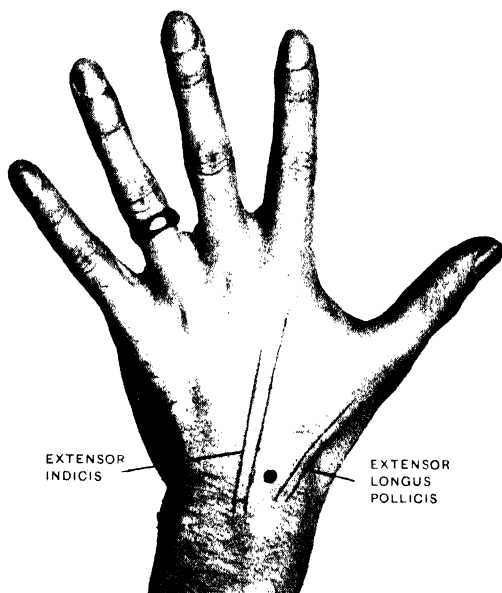
Fig. 629. Needling the wrist-joint. The needle is passed below the distal end of the radius between the tendons of the extensor longus pollicis and the extensor indicis.

The Wrist-joint. —

Needling.—The distal end of the radius is palpated and the needle is passed between the tendons of the extensor indicis and the extensor

longus pollicis (*Fig.* 629). When this point is chosen the radiocarpal interval can be found readily.

Drainage. — A straight incision over the dorsum designed to pass between the tendons referred to above is probably the most useful. A counter-incision over the ulnar side of the dorsum of the wrist may be indicated. Robert Jones's cock-up splint is applied.

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CHAPTER XXXVI

NERVES AND TENDONS

REPAIR OF DIVIDED NERVES

IF divided nerves were always sutured when the original wound received attention, many of the difficulties and disappointments of this branch of surgery would be minimized. By adopting adequate incisions to expose injured blood-vessels, such as have been described in this work, the possibility of overlooking certain divided nerve-trunks is lessened. Those nerves which have not received full attention in the matter of exposure will be dealt with later in this chapter.

NERVE SUTURE

The finest catgut and a fine round-bodied needle are employed. Use the utmost gentleness in picking up the nerve; there is no difficulty in obtaining a hold of the nerve-sheath with fine dissecting
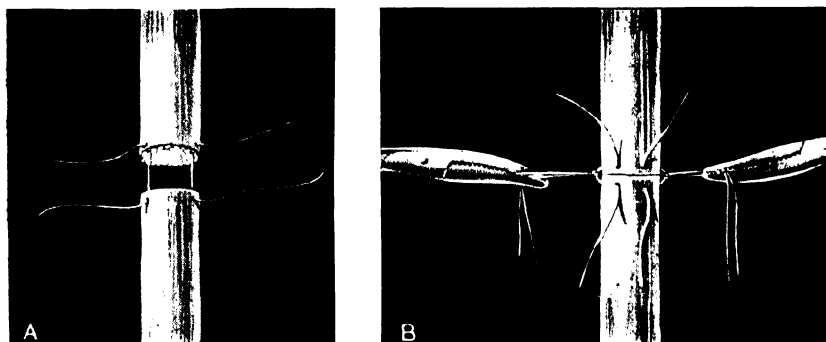
Fig. 630.—Method of suturing a nerve. A, Stay sutures are introduced. B, Fine interrupted catgut stitches approximate the nerve-sheath.

forceps. After introducing two stay sutures (*Fig.* 630, A), approximate the divided ends with interrupted stitches (*Fig.* 630, B). As far as possible, these stitches should penetrate the nerve-sheath only. The entire circumference is united. When this has been accomplished satisfactorily, snip away a small piece of fascia from beneath the skin wound and wrap it loosely around the suture line. A couple

of stitches through this fascia will convert it into a loose-fitting collar to protect the junction.

The convalescence of cases of nerve suture is long and tedious. Months must elapse before we know if function and sensation will return, months of the most skilful massage and correct splinting if the best possible result is to be obtained. In this connection I feel compelled to record a curious phenomenon :—

One hour after having put his hand through a pane of glass, J. C. C., a young man, was admitted into the Liverpool Royal Infirmary with a cut wrist. On examination there was a typical loss of sensation, and the card test showed weakness of the interossei. At operation the flexor carpi ulnaris was seen to be divided. Drawing the tendon aside caused a clot to become dislodged and the ulnar artery began to spurt. This was ligatured. The ends of the cut ulnar nerve were readily found and sutured in the manner just described. After the tendon and the skin had been united the wrist was put up on a plaster splint in flexion. Fourteen days later the patient was examined and there was complete return of function, both sensory and motor.

I am at a loss to explain this pleasing result, and regarded it as unique until I heard of a similar case which occurred at the General Hospital, Birmingham.

EXPOSURE OF INDIVIDUAL NERVES

The Median and Ulnar Nerves at the Wrist.—The majority of cases of cut nerves requiring immediate suture are caused by incised wounds in the vicinity of the wrist. Suture of the median and ulnar nerves in this situation presents no particular difficulty. We will pass on to some nerve injuries in other situations which require more detailed consideration.

The Ulnar Nerve at the Elbow.—In addition to suture, the nerve should always be transposed in front of the internal epicondyle and a bed made for it in this situation. For this procedure it will be found convenient to have the arm across the patient's chest and to stand facing the forearm—that is, to stand on the side of the sound limb. If the lower part of the forearm and hand are wrapped in a sterile towel, the hand and forearm can be twisted into various positions to suit particular circumstances at various stages of the operation. The incision follows the ulnar groove, passing in a straight line from a point one inch above the groove to three inches below the groove.

The proximal end of the nerve is dissected up with due regard for any branches which may be given off. Likewise the distal end is followed, freeing it from the fascia which bridges the ulnar groove. Proceeding, the nerve is traced under the fascia covering the common flexor origin—it will be seen to dive under the fibrous arch uniting

the heads of the flexor carpi ulnaris. There is no difficulty in follow-
ing it for some distance, and it can be readily mobilized. We have
now dissected free both ends. Twist the forearm so that the front
of the epicondyle is visible. Unite the nerve and wrap it with fascia.
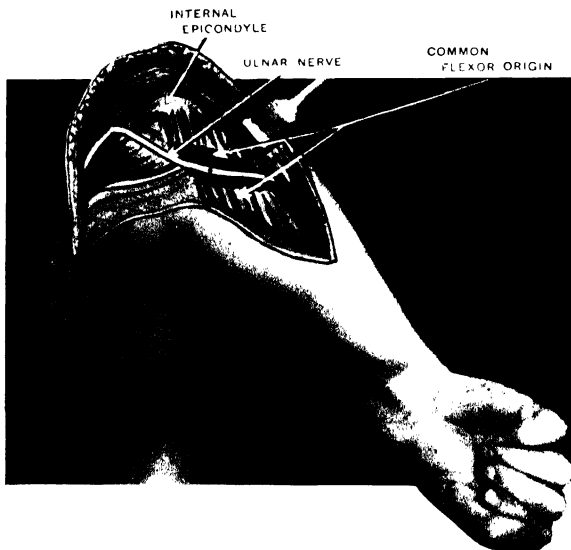
Fig. 631. Suture of the ulnar nerve after transposing it anteriorly. A
bed has been made for the nerve in the muscular mass which constitutes the
common flexor origin.

As it lies loosely on the front of the elbow it is obvious that a bed
for it can be made very simply. Make an incision about half an inch
deep in the common flexor origin (*Fig.* 631). Place the nerve into
the furrow and bury it neatly by sewing up the muscle. When the
operation is completed, bandage the flexed arm to the side.

The Musculospiral Nerve, below and in its Groove. The arm
should be laid across the chest. The hand may be attached to the
table by a length of bandage. Identify the external epicondyle.
Above it, by palpating deeply, the supracondylar ridge can be felt.
Here arises the supinator longus. Commence the incision between
the origin of the supinator longus and the brachialis anticus, and
carry it upwards in the direction of the musculospiral groove. Dissect
in the interval between the supinator longus and the brachialis
anticus. The musculospiral nerve will be found lying very deeply
in this groove. The nerve is now traced upwards. Towards its
groove it will be found to pass deep to the outer head of the triceps.
The outer head of the triceps arises by a flattened tendon from
the back of the humerus. By dividing this outer head and the

aponeurotic bridge across the musculospiral groove, an excellent view is obtained. The musculospiral nerve and the superior profunda artery are displayed (*Fig.* 632).
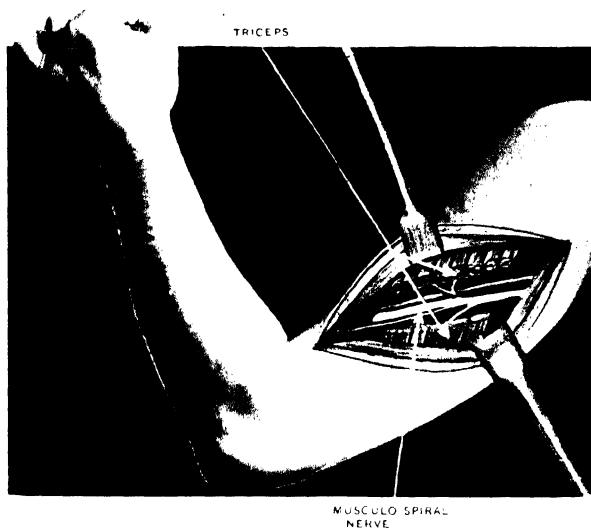
Fig. 632.—Exposure of the musculospiral nerve in its groove. The triceps has been divided.

The Posterior Interosseous Nerve.—The course of the posterior interosseous nerve is very short, but being a purely motor nerve its
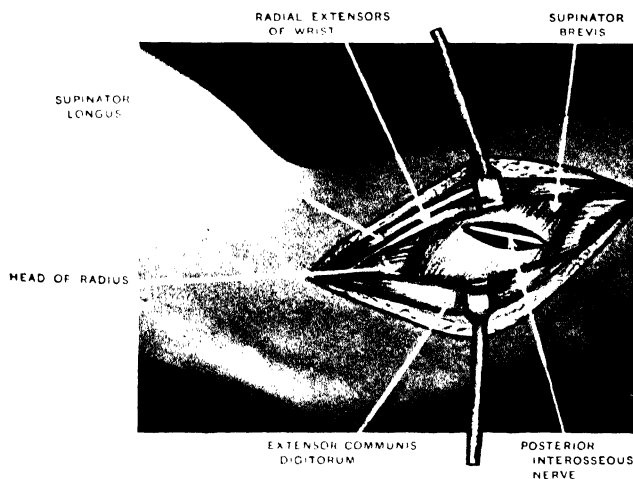
Fig. 633. Exposure of the posterior interosseous nerve. (*After Souttar.*)

suture yields most satisfactory results. Naturally, division of this nerve is a great rarity, but it is not unknown in wounds of the outer side or back of the forearm. The arm lies across the patient's chest. Palpate the head of the radius. Commence the incision over the head of the radius and carry it down the shaft rather nearer the posterior than the anterior aspect. Expose clearly the common extensor origin and find the interval between the extensors of the wrist and those of the fingers. The extensor communis is thus separated from the extensor carpi radialis, and the supinator brevis comes into view. Palpate this muscle. The nerve can be felt winding round the neck of the radius. Incise the muscle and the nerve is exposed (*Fig.* 633).

II. S. Souttar describes three cases of suture of this nerve with complete return of all power to the extensors.

The Median Nerve.—The median nerve will be exposed with the brachial artery (*see* pp. 557–560) in the upper arm and at the elbow. In the lower part of the forearm and at the wrist, where it is frequently divided, there should be no difficulty in finding the nerve (*see* *Fig.* 635).

The Great Sciatic Nerve.—The patient should lie on his face. The upper part of the sciatic nerve may be exposed by the method described already for the gluteal and sciatic arteries (*see* p. 571).

HAMSTRINGS
RETRACTED
MEDIALLY
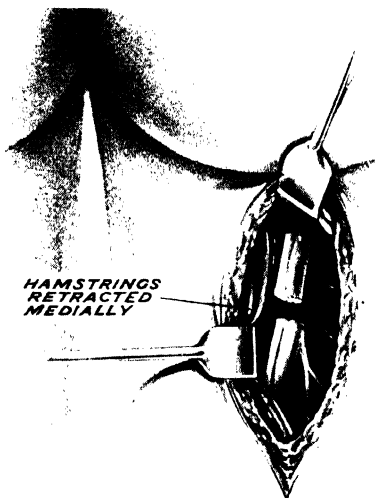
Fig. 634.—Exposure of the great sciatic nerve.

Exposure of the Nerve.—Take a point midway between the great trochanter and the tuber ischii; this is the surface marking. Commencing just below the gluteal fold make an incision passing directly downwards. Identify the hamstrings and retract them medially. Deeply placed in the wound the great sciatic nerve will soon be found. If there is difficulty in finding the upper end of the nerve the gluteal muscles must be retracted upwards (*Fig.* 634). The division of the sciatic nerve is irregular. Sometimes it divides high up in the thigh. As soon as the nerve-ends are found the knee should be flexed, which considerably lessens tension. After the nerve has been sutured and the skin wound closed, the flexion of the knee should be maintained at first by bandages. Later a plaster shell to fix the hip and the flexed knee is desirable. If this is not feasible owing to other injuries, the desired position may be obtained by bending a Thomas splint suitably. The patient must be nursed on his face for a few days; later he can be turned on the sound side, supporting the limb with pillows.

UNION OF DIVIDED TENDONS

A severed tendon should be sutured at once. If operation is undertaken soon after the injury, the finding of the proximal end is comparatively simple, as is approximation of the divided ends. It is when the injury has been overlooked for weeks or months that special difficulties arise, which do not concern us here. Accidental division of tendons most often occurs at the wrist (*Fig.* 635).

CUT WRIST

Before commencing operation apply rubber tubing tightly from below the elbow downwards to the lower third of the arm (*Fig.* 636). In addition to controlling hæmorrhage by compressing the muscle bellies downwards the tubing will help in the search for the divided ends. Excise the wound edges and examine the divided structures. Attend to arteries first, divided nerves second, and then proceed to unite tendons.

For uniting a divided tendon the following method can be recommended, for it is applicable to all tendons, whether flat or round, and it mitigates a fundamental difficulty in tendon suture—'cutting out'. Catch hold of the proximal end of the divided tendon and pull it down. Fix it with Lane's tissue forceps applied one and a half inches from the divided end (*Fig.* 637). Give the tissue forceps to an assistant to hold. Just below the point of transfixion by the forceps, commence to suture. With a straight needle carrying a long piece of No. 2 catgut pass the first stitch right through the middle of the tendon. Bring the needle back again through the whole thickness

of the tendon, so that it comes out near one edge. Stitch over and over along this edge until its extremity is reached, then, with the assistant exerting downward traction on the tendon by means of his forceps, the cut ends come near together while we stitch over and over along the corresponding edge of the distal end for a distance of about three-quarters of an inch. Then a bite is taken through the whole thickness of the tendon, and the needle is brought out on the
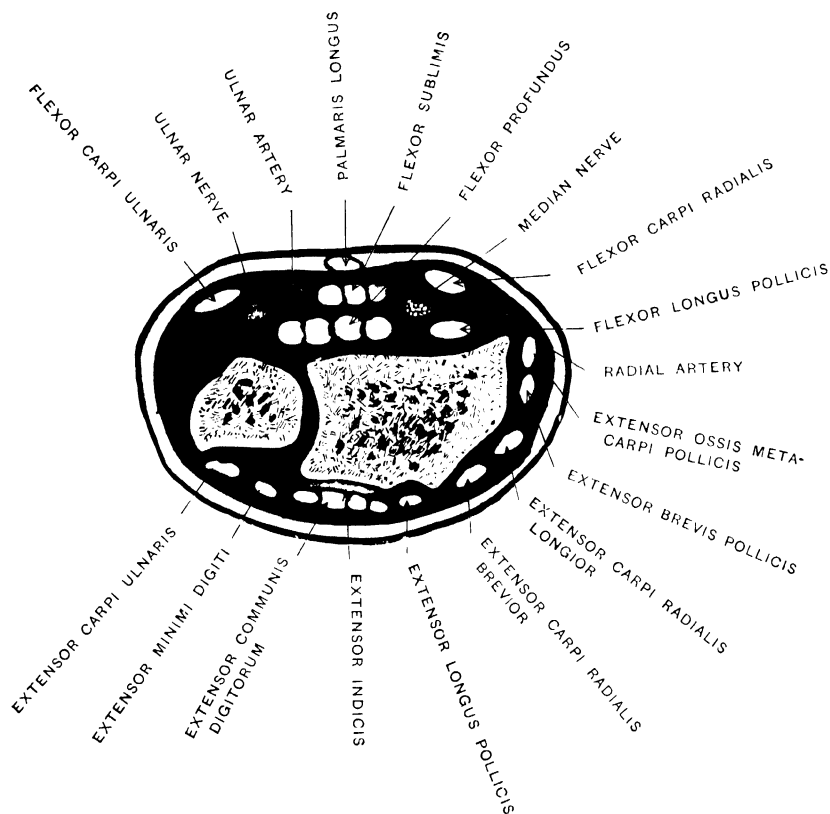
Fig. 635. –Cross-section of the wrist showing the relative positions of tendons and nerves. (Semi-diagrammatic.)

opposite side. Proceed over and over along first the distal and then the proximal edges, until the level of the first stitch is reached. Bring out the suture near its fellow and tie the two ends. Reference to *Fig.* 638 should make this simple technique clear. When necessary, a mattress suture reinforces the point of junction, and is tied not too tightly.

Fig. 636. Cut wrist. A piece of rubber tubing has been applied from above downwards in order to make the proximal ends of the tendon accessible.

(*After Rockey.*)
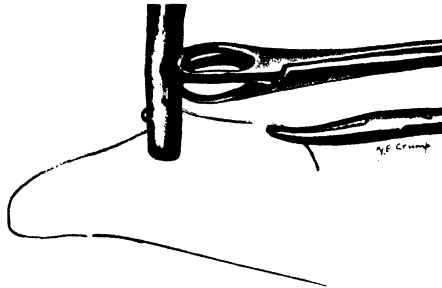
Fig. 637. Union of a divided tendon. The tendon is grasped with Lane's tissue forceps 1½ in. from its divided extremity. This allows the retracted upper end to be held in position while suturing is in progress. The commencement of the suture is shown.

After suture of tendons the limb must be placed in a position which will give the greatest relaxation to the sutured tendons. The position adopted after uniting divided flexor tendons of the wrist is shown in *Fig.* 639. The splint, made of plaster, is very convenient, and readily applicable to any given case.

Difficulties.—

The Proximal End of the Tendon Cannot be Found in the Wound. On rare occasions, especially in the palm, the proximal end of the tendon is difficult to find. Do not grope blindly with a hæmostat : other structures, especially nerves, may be endangered. Make a transverse incision three inches above the wound and systematically examine the underlying anatomy. The missing tendon will surely be found. Pass up a hæmostat from the first to the second wound. Grasp the free end of the tendon and draw it down.

Fig. 638.—A standard method of uniting divided tendons.

The Proximal End Cannot be Found, and it is Inadvisable to Search for it.— If, for some reason such as considerable loss of blood, it is advisable to conclude the operation speedily, it may be prudent to make use of tendon
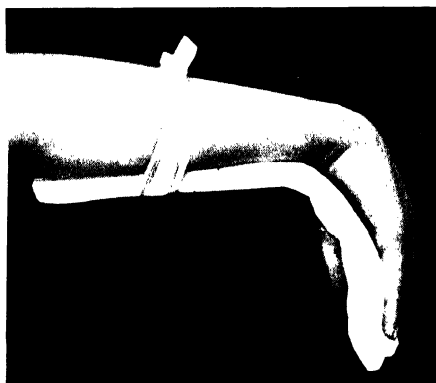
Fig. 639. —Plaster splint for maintaining flexion after suturing flexor tendons of the wrist.

Fig. 640. Tendon transplantation. The distal end of the divided tendon is threaded through a split in the neighbouring tendon and fixed in this position.

transplantation, which often gives excellent results. If there is an intact tendon conveniently placed, this tendon is transfixed in its centre and the distal end of the severed tendon is drawn through (*Fig.* 640) and fixed by sutures.

There is Actual Loss of Substance in the Tendon.—Tendon transplantation may, in certain instances, be made use of. In others tendonlengthening is necessary. There are many ways of lengthening a tendon. *Fig.* 641 shows a simple and satisfactory method.
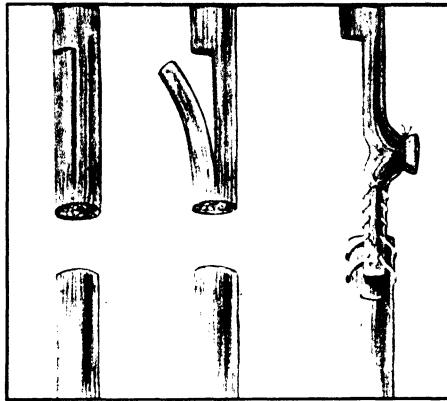
FIG. 641. A method of tendon-lengthening. Note the ligature to prevent the split tendon from splitting too far.

DIVIDED FLEXOR TENDONS BELOW THE WRIST

When tendons are divided in the palm, a longitudinal incision somewhat to the radial side of the middle of the palm (*Fig.* 642, D) will give good access to the main flexor tendons. In the case of fingers or the thumb Garlock's inverted L-shaped incision (*Fig.* 642. A. B. E) may be recommended, for it gives adequate exposure. A transverse incision in the distal flexion crease opposite the base of the affected finger will quickly bring to light a flexor tendon which has retracted (*Fig.* 642. C). When it is the proximal end of the flexor longus pollicis which cannot be retrieved, a longitudinal incision above the wrist (*Fig.* 642. F) will enable this tendon to be found, and by exerting traction on the muscle the tendon may be pushed down its tunnel until the divided end appears in the original wound.

Garlock studied the end-results of 16 cases of primary suture of flexor tendons divided below the wrist, and found the results were as follows :——
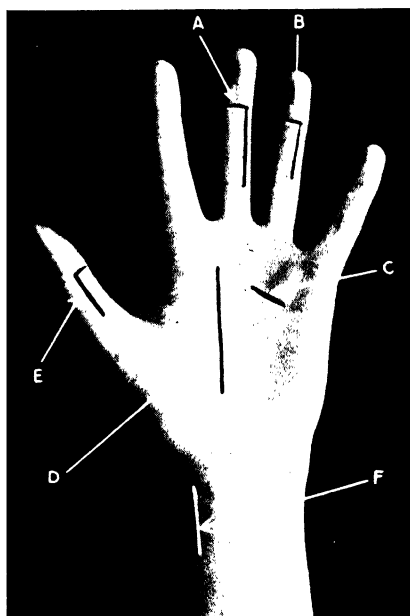
Fig. 642. Incisions for exposing divided flexor tendons. A, For flexores profundus et sublimis digitorum. B, For flexor profundus digitorum. C, For retracted proximal end. (Note: The incision is transverse.) D, For extensive lesion in the palm (the incision is slightly to the radial side of the main flexor tendon). E, For flexor longus pollicis near its insertion. F, For retracted proximal end of flexor longus pollicis. (After Garlock.)

SITE OF INJURY

Near insertion of profundus tendon
Over middle phalanx   ..   ..
At proximal phalanx (both tendons)
In palm   ..   ..

Suppurative Tenosynovitis of the Hand and the Forearm.

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    ROCKEY, E. W., *Surgical Clinics, Chicago*, 1934, xiv, Dec., 1485.
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CHAPTER XXXVII

URGENT AMPUTATIONS

In works on operative surgery, especially those designed to meet the needs of the examination room, much space is devoted to classical amputations. Only a few stereotyped amputations are necessary in emergency surgery.

LEAVE HEAD IF POSSIBLE TO FILL GLENOID CAVITY.

2' OF BONE SHORTEST STUMP OF FUNCTIONAL VALUE

SAVE ALL POSSIBLE

3' THE SHORTEST STUMP OF FUNCTIONAL VALUE FROM ARTIFICIAL LIMB POINT OF VIEW

SAVE ALL POSSIBLE

GREAT VALUE BECAUSE IT PRESERVE PRONATION AND SUPINATION

SAVE EVERY PORTION OF HAND POSSIBLE.

2' STUMP MEASURED FROM PUBIS THE SHORTEST EVER OF VALUE ABOVE THIS DISARTICULATION.

SAVE ALL POSSIBLE

2' OF TIBIA SHORTEST EVER OF VALUE

SAVE ALL POSSIBLE

THE 7" STUMP. THE MODERN SEAT OF ELECTION.

SYME

Fig. 643. Preferable sites for amputation.

(*After Ochsner.*)

Urgent amputations may be called for: (1) In a grave infection of the limb threatening life ; (2) In spreading gangrene of the limb ; (3) In crushing accidents.

The first thought is to save the patient's life. The second should be to plan an amputation suitable for an artificial limb. To attain the latter objective much help can be derived from *Fig.* 643,

which shows preferable sites for amputation from an artificial-limb point of view.

SOME GENERAL CONSIDERATIONS

Instrumentarium.—

Syme's Knife.—A Syme's knife (*Fig.* 644) is desirable for many amputations. There is no necessity for a variety of knives, or for anything longer than Syme's ankle knife.

Fig. 644. Syme's amputation knife. The blade is 3½ in. long.

Muscle Retractors.—An efficient muscle retractor, so essential for amputations, can be made from a piece of stout calico. For use in the case of the femur and humerus one slit is made (*Fig.* 645, A). For amputations of the forearm and the leg below the knee a double slit is necessary (*Fig.* 645, B), so that the tongue of material can be passed between the radius and ulna or the tibia and fibula. It is advisable to have the edges of the slit hemmed. The cloth retractor is sterilized by boiling with the rest of the instruments.
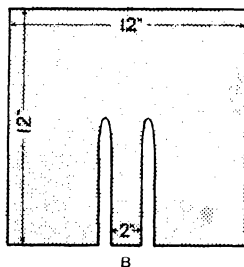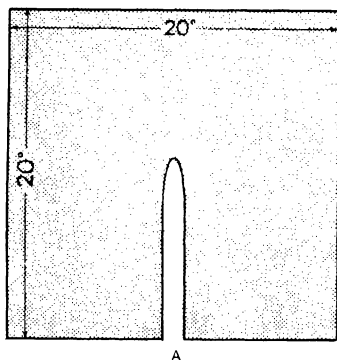
Fig. 645. Calico retractors. A, For the humerus and femur. B, For the forearm, or leg below the knee ; the tongue of material is passed between the radius and ulna or the tibia and fibula, as the case may be.

Control of Hæmorrhage.—

By the Application of a Tourniquet.—The limb should be elevated for two minutes in order that the blood may gravitate. A tourniquet is then applied. It is important not to keep the limb elevated too long, for under these conditions vasoconstriction may occur, and when the limb is lowered and the vasoconstriction passes off the tourniquet may prove ineffective.

The type of tourniquet is a matter for individual preference. A length of new, half-inch rubber tubing is very satisfactory for the upper limb. For the thigh Esmarch's tourniquet is popular, but it requires practice to apply it efficiently.

Petit's tourniquet (*Fig.* 646) can be applied by a novice and has much to recommend it.

By a Preliminary Ligature of Main Vessels.—This mode of controlling hæmorrhage is particularly suited to amputations through the hip- and shoulder-joints.

By Temporary Compression of the Exposed Main Vessels. In rare instances, when for some reason a tourniquet is inadvisable, such as great œdema of the soft parts, the main artery and vein can be exposed at some distance from the proposed amputation and the vessels held between the finger and thumb of an assistant.
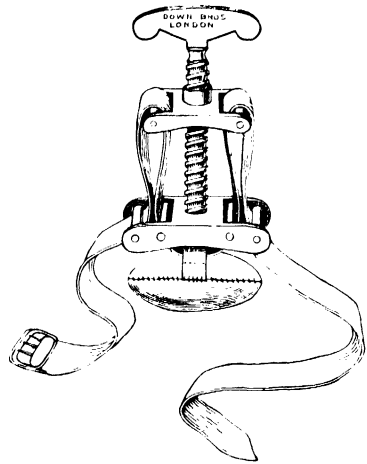
Fig. 646.—Petit's tourniquet.

Dealing with Divided Vessels and Nerves.—

Vessels.—Large vessels are ligated after the bone has been severed but before the tourniquet is loosened. A double ligature in the form of Ballance's stay-knot (*see* p. 547) is recommended for the principal artery.

Nerves. The reader's attention is directed to the necessity of shortening all principal nerves. Except in most urgent cases, each nerve is grasped in a hæmostat, pulled down, crushed and ligatured, and the portion distal to the ligature cut off. As this manœuvre is accompanied by some shock, large nerves, such as the sciatic, are injected with local anæsthetic before being crushed. By crushing and ligaturing divided nerves the unbridled protrusion of axis cylinders is minimized, and this helps to prevent those painful false neuromata which so often mar an otherwise successful amputation.

TWO SPECIAL EMERGENCY METHODS

Before entering into details concerning individual amputations, two important emergency measures will be described.

The Guillotine Amputation. The guillotine operation is very simple and rapid, but it is only to be recommended when the patient is *in extremis*, for it is but a temporary measure. Its chief disadvantage is that eventually a second operation (re-amputation) is

necessary. The guillotine operation proved to be a life-saving measure in war wounds with spreading gangrene, amputation being performed just above the gangrenous area. The indications for its employment in civil life are very limited.

Technique.—A tourniquet is applied. The skin is divided by a circular sweep. The muscles are severed by a 'tour de maître' (*Fig.* 647) at the level to which the skin retracts. Without applying a muscle retractor the bone is divided. Bleeding points are secured,

Fig. 647.—The 'tour de maître'.

and, unless the patient is moribund, nerves are shortened. A dressing is then applied to the stump, which is left completely open.

After the infection has abated and granulation commenced the bone will be found to be protruding a considerable distance. Extension to the soft parts can now be applied, and this can be satisfactorily undertaken by the method shown in *Fig.* 648, a principle which will be found useful in other healing amputation stumps in which primary union could not be obtained.

The Sleeve Amputation.—The sleeve amputation is a method designed by Sir W. I. de Courcy Wheeler to meet certain emergency
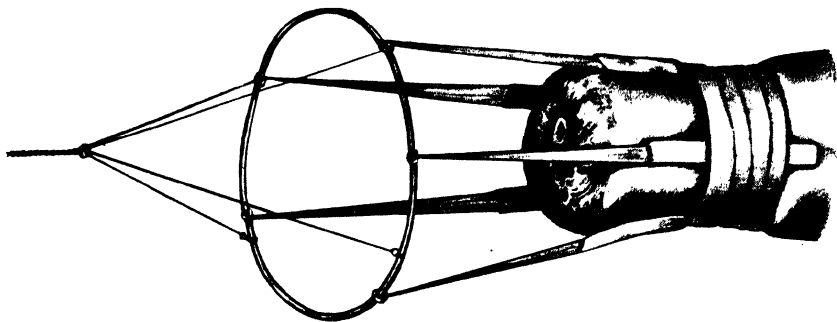
Fig. 648. Extension applied to the soft parts of a stump by a metal ring and strapping.

conditions with the least possible surgical risk. The operation is particularly suitable in compound fractures of the femur where the limb below the fracture is mutilated or gangrenous. The principle of the operation can be seen in *Fig.* 649. The mutilated limb below the knee-joint is removed. Vessels are ligatured and nerves shortened. The distal fragment of the femur, grasped with a pair of lion forceps, is twisted hither and thither while the soft parts are peeled off the bone with a periosteal elevator.

To quote one of Sir William Wheeler's cases :

The patient had a simple fracture of the femur in the upper third. Eight days afterwards the leg was gangrenous as far as the knee. The thigh was swollen, œdematous, and discoloured. A tourniquet could not be employed owing to the condition of the soft parts of the thigh. The main vessels were therefore exposed and compressed between the finger and thumb of an assistant until a guillotine amputation had been performed through the knee-joint just above the line of gangrene. The distal fragment of the femur was then removed by the technique described above, leaving a sleeve of soft tissue.

Fig. 649. The sleeve amputation Removing the distal fragment of bone (*After Sir W. I. de C. Wheeler.*)

AMPUTATIONS OF THE LOWER LIMB

Disarticulation at the Hip-joint.—Amputation at the hip-joint is very rarely necessary in emergency surgery. I have performed the operation but twice as an urgent measure.

Position of the Patient.—The patient lies slightly turned towards the sound side. The pelvis rests on the end of the table and the sound limb is secured to a leaf of the table.

Stand on the outer side of the limb. The assistant supporting the leg must be fully acquainted with the meaning of the terms 'adduction' and 'abduction' and be able to execute these movements deftly when the order is given.

Preliminary Ligature of the Femoral Vessels.—Make a vertical incision A-B (*Fig.* 650) three inches in length in the line of the femoral artery. Ligate the femoral artery and vein.
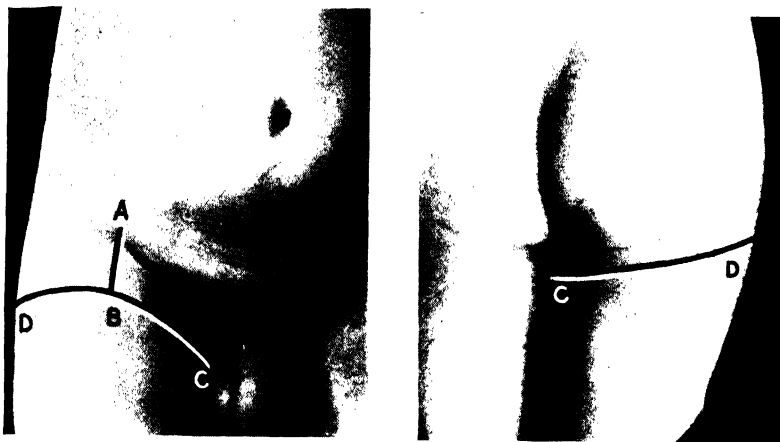
Fig. 650. Incision for amputation at the hip-joint.

Completing the Incision.—From the lower extremity of the vertical incision, sweep inwards along the line B-C to a point four inches below the perineum. Then make the incision B-D, which runs below the base of the great trochanter. Carry the incision along the line C-D across the back of the thigh.

Dissect up the whole circumference of the skin and fascia.

Division of Muscles.—Direct attention to the outer side of the thigh. Divide the muscles right down to the bone. Tie the external circumflex artery. *Ask the assistant to elevate the limb.* Divide the insertion of the gluteus maximus and the muscles on the postero-internal surface. Try to find and ligature the internal circumflex artery.

Tell the assistant to lower the limb to the horizontal plane and to *adduct and rotate inwards*. Divide all muscles attached to the great trochanter. Tell the assistant to *abduct and rotate outwards*. Divide any remaining muscles.

The capsule of the hip-joint is now in full view. Open the capsule anteriorly with the amputation knife. Dislocate the head of the femur. Divide the remaining part of the capsule and the ligamentum teres with strong curved scissors. The limb can now be removed. Shorten nerves and proceed to unite the skin-flaps. It is surprising how readily the posterior flap can be brought forwards. Drain the wound.

Fig. 651 shows the end-result in a patient who had the operation performed.

Amputation through the Thigh (lower, middle, and upper third). ·'Through the thigh' is an amputation often called for.

Before the patient is taken to the operating theatre order the limb to be securely bandaged. Say to the nurse : '' Make a parcel of this limb up to such and such a level, and make certain that the parcel will not come undone.'' In this way the infected area is isolated from the field of operation.

Fig. 651. Amputation through the hip-joint. The patient had a virulent osteomyelitis with infected arthritis of the knee in a limb deformed by old-standing infantile paralysis.

The patient is anaesthetized. Spinal anaesthesia may be used if there is some contra-indication to general anaesthesia, such as diabetes.

Making Ready for the Amputation.—If the end of the table has a leaf, let it down. Have the patient's buttocks brought right down to the edge of the table. Firmly bandage the sound limb to the leaf or leg of the table (*Fig.* 652). Elevate the limb and apply a tourniquet, as far up as possible. Having draped the area surrounding the field of operation with sterile towels,* stand on the inner side

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* A large sheet with a slit in the centre is convenient for draping the upper part of the thigh and the trunk. The foot is passed through the slit and the sheet is carried up above the knee to the desired level, when the edges of the slit are clipped to the skin.

in the case of the left leg, and on the outer side in the case of the
right.   Ask the assistant supporting the limb to raise the leg.   Make
a small transverse cut in the skin on the *back* of the thigh at the
level at which it is desired to divide the bone (*Fig.* 653, B).   Have the
limb lowered until it is in a straight line with the body.   Make
another small cut in the skin on the *front* of the thigh six or eight
inches lower than the first (*Fig.* 653, A).

Fig. 652.   Amputation through the thigh.   The   ured
to the table.   A and B show the small guiding tran-
in the text and in *Fig.* 653.

The Amputation.—Using an ordinary scalpel, describe an ellipse
joining the two cuts just made.   This incision is through skin and
fascia only.   Apply a Lane's forceps to the proximal side of the cut
edge of the front of the thigh, and commence to dissect up the flap.
Proceed to raise the skin and fascia only, for a distance of about
three inches.   Now substitute the Syme's knife for the scalpel.   Still
raising the flap, cut obliquely through the muscles of the front of the
thigh in such a way that the flap contains more and more muscle.
In this manner we proceed for another three or four inches until the
level of the original skin mark on the back of the thigh is reached.

With a stroke or two of the scalpel dissect up the skin for three-quarters of an inch on the back of the thigh. Clasping the Syme's knife with the blade looking towards one and the arm passed under the limb, describe a 'tour de maître' right down

Fig. 653. Incision for amputation of the thigh. A small transverse cut is made on the back of the thigh at B, which is the level at which it is proposed to section the bone. A small transverse cut is then made at A in front of the thigh, which is to be the extremity of the flap. A and B are now joined by an elliptical incision.

to bone. Make certain that all structures are divided (*Fig.* 654). Particularly is this necessary in the neighbourhood of the linea aspera. Take a broad periosteal elevator and rapidly bare the bone as high up as can be reached with convenience. Apply the cloth muscle retractor. See

Fig. 654. Amputation of the thigh by Kocher's method. The anterior flap has been turned up and the muscles at the back of the thigh have been divided.

that the assistant has got a firm grip of the retractor with two hands and is pulling the muscles upwards with all his might (*Fig.* 655); it should be your endeavour to section the bone at the highest level

Fig. 655.—Amputation through the thigh. The retractor in position ready for the division of the bone.
Inset. The appearance of the stump at the completion of the operation.

which can be obtained, and this is why it is so necessary to see that the muscles are effectively retracted. With a Butcher's saw cut
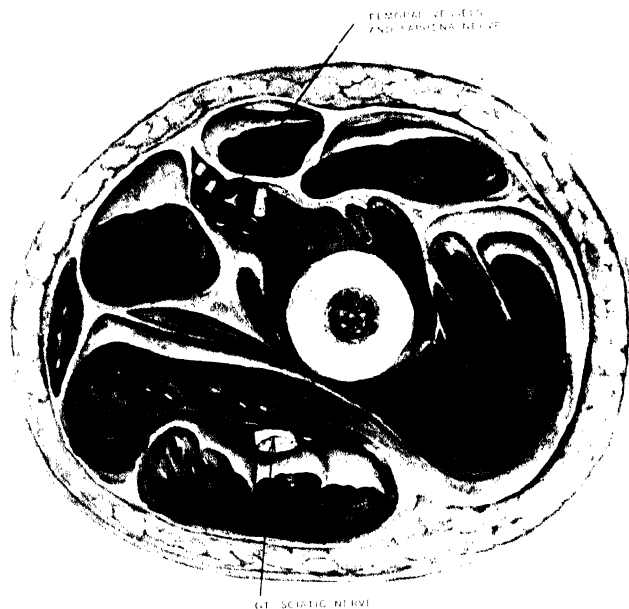
Fig. 656.—Transverse section through the middle third of the left thigh.

transversely through the bone. The detached limb is removed.
Elevate the stump so that the cut surface (*Fig.* 656) looks upwards,
and then remove the muscle retractor. Doubly ligate the femoral
vessels. Catch hold of the sciatic nerve, pull it down, and crush and
ligature it, after injecting local anæsthetic. Deal with the long
saphenous nerve in a similar manner. Now ask an assistant to
loosen the tourniquet. Pick up any bleeding vessels and ligature

Fig. 657.   Amputation through the middle third of the thigh by Kocher's method.
The stump.

them. With deep mattress sutures unite the muscular masses in
such a way as to bury the divided bone. Suture the skin and
drain the wound. If 'dog ears' tend to appear at the ends of
the wound, they may be snipped off with scissors and the resulting
cut surface of skin sutured or utilized for the passage of a drainage
tube.

Fig. 657 shows a patient in whom the amputation was performed
for osteomyelitis of the tibia complicated by purulent arthritis of
the knee-joint.

Amputation of the Leg: the 7-in. Stump (the modern 'seat of election').—When contemplating a permanent stump, amputation through the *lower third* of the leg must be condemned wholeheartedly. The resulting stump is poorly nourished and no end-bearing is possible; it often becomes the seat of chilblains and it atrophies as age advances. The only justification for its employment is as a temporary measure in severe sepsis.

On the other hand, amputation just below the middle of the leg is free from these objections, and is, moreover, excellent from a functional point of view (*Fig.* 658). One should aim at leaving 7 in. of the tibia and slightly less of the fibula. The 7-in. stump is so satisfactory from an artificial limb point of view that this indeed is the modern 'seat of election'.

In urgent surgery amputation through the leg is most often required for crushing injuries. Attention has been directed already to the advisability of resorting to primary amputation in cases of comminuted, compound, contaminated fractures communicating with the ankle-joint (pp. 577, 599).

Fig. 658. **A,** Amputation through the leg. The stump. Undertaken for a crushed foot with dvement of the ankle-joint. **B.** The patient with artificial limb fitted. Two years later the patient ites: " I hardly ever use a stick, and just walk th a slight limp as a man would with a corn."

Technique. Before the patient is taken to the theatre the foot is wrapped in a sterile towel, and the leg is shaved and prepared with iodine. As soon as he is anæsthetized a tourniquet is placed around the thigh. Flexing the knee and taking the inferior border of the patella as the guide, 7 in. of tibia is marked off by a scratch on the skin.

The Flaps.—Flaps can be fashioned from any healthy skin available. If one long flap can be fashioned from the antero-external aspect (*Fig.* 659, A), it answers the purpose well. A long anterior and a short posterior flap can also be recommended (*Fig.* 659, B). When a single flap is used, care should be taken not to make it too
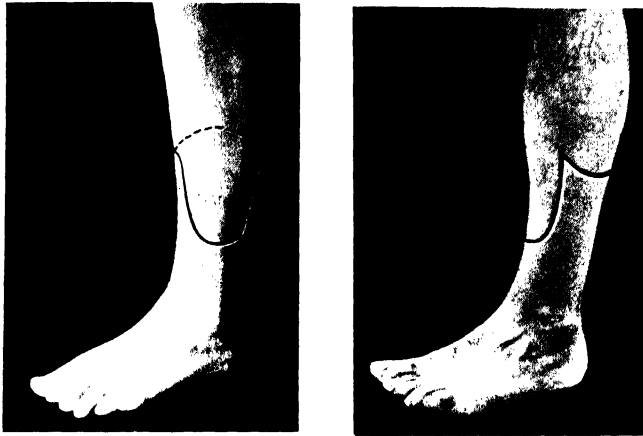
A   B

Fig. 659.—Flaps for amputation of the leg. **A.** One long flap; **B.** A long anterior and a short posterior flap.

broad, otherwise when it is sewn into place a crevice will tend to form down the centre. To prevent other crevices forming, the corners of the flap should be rounded. A good method of finding out just how much flap is necessary is to encircle the limb tightly with a length of catgut at the proposed point of section. The length of catgut shows the circumference of the limb. With a little ingenuity it can

Fig. 660. Method of drawing the middle tongue of the cloth retractor between the two bones.

be laid on the skin in such a way as to give an approximate idea of the size of the flap required. It is best to err on the side of having too much; it can always be trimmed with scissors before being sutured into place. Dissect up the flap—skin and subcutaneous tissue alone are required, though a little muscle may with advantage be included in the base of the flap.

Bear in mind that in this amputation there is always a tendency to sever the bones too high; therefore dissect up the flap until the base lies just distal to the scratch on the skin which marks the 7-in. level.

Fig. 661.—The 7-in. stump. Dividing the tibia.
Inset.—Method of bevelling the crest of the tibia.

Having pulled the flap upwards, perform a 'tour de maître' with a Syme's knife just a millimetre or two below the scratch on the skin. Cut right through the muscular masses at right angles until the bone is reached. Drive a long hæmostat through the interosseous membrane (*Fig.* 660), and by its means bring the centre tail of the three-tailed calico retractor between the bones. The muscles are now held out of the way (*Fig.* 661).

Division of the Bones.—The fibula is divided half an inch higher than the tibia. A frame saw may be used for the former or a pair

of Exner's rib shears. The interosseous membrane should not be destroyed above the level of the division of the fibula, otherwise the end of the fibula tends to project forwards. The tibia is divided with a saw, after which the sharp cut end of the crest is sawn off obliquely (*Fig. 661*— inset).

All nerves should be shortened. The tourniquet is now removed, and all bleeding points are ligatured. The flap is then sutured accurately into place, and drainage is provided by means of a rubber tube. Leg stumps should always be nursed on a back splint.

Fig. 662. Orr's amputation at the modern seat of election. The fascial flap is ready to be sutured into position.

Fig. 663. Orr's amputation. The fascial flap has been stitched to the cut ends of the muscles. (*After T. G. Orr.*)

Orr's Operation.—When the patient's condition allows a more prolonged operation and plenty of skin is available, Orr's modification of the above procedure has much to recommend it as a permanent amputation. Long anterior and short posterior skin-flaps are made. The anterior flap contains the deep fascia, while the

posterior consists only of skin and subcutaneous tissue. After the
skin-flaps have been turned up, a second flap consisting of fascia
fashioned from the posterior aspect of the limb is turned up also (*Fig.*
662). Removal of the limb is carried out as described in the fore-
going section. After nerves have been shortened and vessels ligatured
—haemostasis must be as perfect as possible when this method is
used—the fascial flap is brought over the ends of the bone, sutured
accurately into place, and anchored to the various muscular masses,
as shown in *Fig.* 663.

Amputation through the Ankle-joint: Syme's Amputation (modified).
—Syme's original operation has been modified so that an artificial
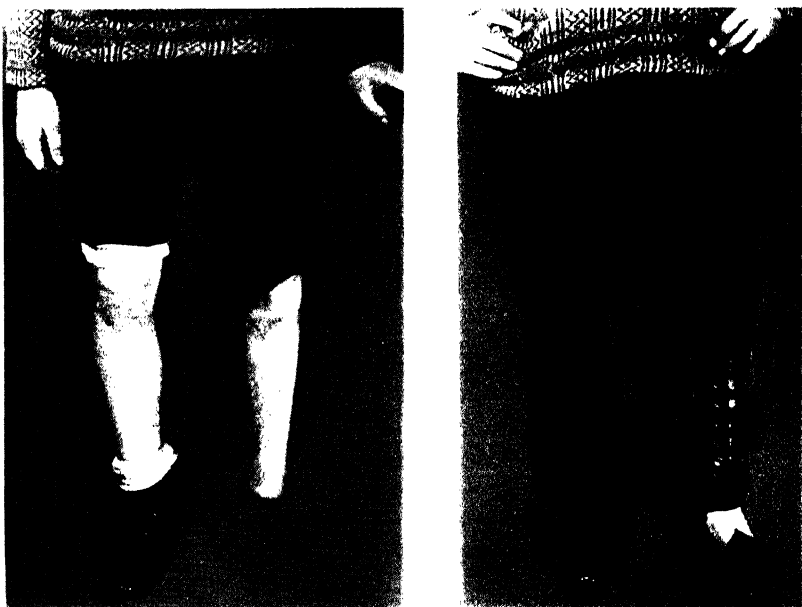
Fig. 664. Result of a modified Symes' amputation,
urgently for a crushed and lace

foot can be fitted to the stump. A well-performed Syme's amputa-
tion gives an excellent and lasting result (*Fig.* 664), but some consider
that it is inferior to the 7-in. stump. " The usual cause of a Syme's
stump being unsatisfactory is sepsis " (Huggins). Thus, if amputa-
tion is necessary for a crushed foot, the wounds being grossly con-
taminated, even though Syme's amputation is possible, it is wiser to
remove the limb at the modern seat of election.

Technique. —A tourniquet is applied to the thigh. The foot projects over the end of the table.

The First Incision. —Commencing just behind the tip of the internal malleolus, carry the incision downwards, sloping somewhat towards the point of the heel, across the sole, to a point half an inch above the tip of the external malleolus. Divide all structures right down to bone.

The Second Incision. The extremities of this U-shaped incision are united by a sweep of the knife across the front of the ankle, *this incision being slightly convex upwards* (*Fig.* 665). Divide all structures down to bone, and open the ankle-joint.

Fashioning the Flap. Divide the external and internal lateral ligaments from their attachment to the malleoli. Dislocate the astragalus forwards by strongly depressing the foot. With the Syme's knife used with a sawing movement, cut out the heel flap from above by working round the convexity of the heel in order to meet the U-shaped incision on the sole (*Fig.* 666). During this all-important manœuvre the watchword is *keep close to the bone*, otherwise the blood-supply to the flap will be imperilled.

The amputated foot is now removed, and with a few cuts of the knife the

Fig. 665. Incision for the modernized Syme amputation.

base of the flap is dissected free from the back of the tibia and fibula.

Treatment of the Tibia and Fibula.—Make a circular incision through the periosteum a quarter of an inch above the highest part of the articular surface of the tibia, at which level the two bones are still in contact. Retract the flap, and saw through the bones at the level of the periosteal incision, making sure that the cut surface is horizontal. Remove with a saw any projecting portions of bone so as to give a rounded contour to the cut surface. As a rule a small portion of the edge of the fibula requires excision.

Vessels and Nerves.—Ligature the anterior tibial vessels and the plantar vessels. Shorten the posterior tibial nerve, the anterior tibial nerve, the internal and external saphenous nerves, and, if possible, the two divisions of the musculocutaneous nerve. The tourniquet is now removed and all bleeding points are ligatured.
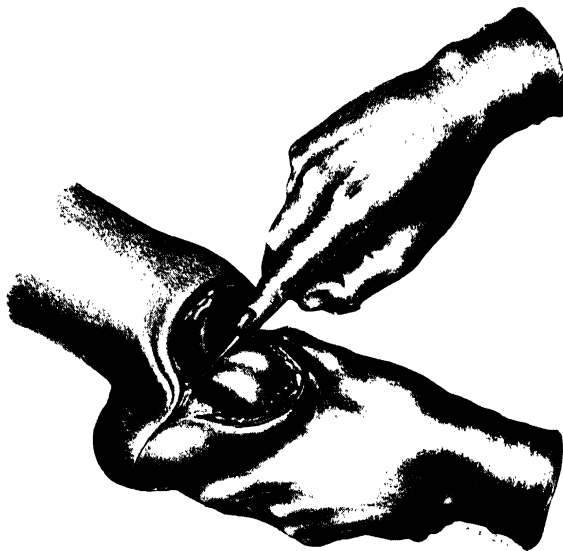
Syme's amputation.

Bring forward the flap, which should form a complete cap over the ends of the bone, and suture it accurately into place. If there are any 'dog-cars' at the points where the original incisions met. these should be removed with scissors. Drain the wound posteriorly on the outer side. Dressings having been applied, the limb should be placed on a back splint of sufficient length to fix the knee and to allow the end of the stump to project beyond it for a few inches.

Fig. 667.—Amputation of the great toe, performed for laceration and crushing following a motor cycle accident. The head of the metatarsal has been preserved. The patient, a girl of 20, writes : " The loss of the toe is no inconvenience to me. I dance, etc., as well as ever."

Amputation of Toes. This can be briefly dismissed. In general, the principles set out in amputation of fingers may be followed, with one important exception. No effort should be spared to save the head of the first metatarsal. This structure is of the greatest importance in the weight-bearing function of the foot as a whole (*Fig.* 667).

AMPUTATIONS OF THE UPPER LIMB

Considerable responsibility rests with the surgeon in advising amputation in the upper limb, for the efficiency of an artificial arm bears no comparison with that of an artificial leg.

Amputation at the Shoulder-joint.—Fortunately disarticulation at the shoulder-joint is rarely required in urgent surgery. Even two inches of the shaft of the humerus provide a stump to which an artificial arm can be fitted, but above this level the artificial limb can be but an ornament. If amputation at the shoulder is inevitable, an effort should be made to leave the head of the humerus in the glenoid cavity. This prevents the subsequent prominence of the acromion, which is unsightly and a nuisance to the patient.

Operation. Have the arm abducted and rotated outwards. Make an incision commencing at the tip of the coracoid process and passing downwards towards the junction of the pectoralis major with the humerus. The pectorales major and minor are divided, the axillary vessels found and ligatured, and the main brachial nerves injected, clamped, ligatured, and cut. The arm is now encircled, as high as possible, by an incision through the skin and fascia (*Fig.* 668). Flaps are dissected up a short distance, then the muscles divided by the circular method right down to bone. The outer flap which contains the deltoid is raised from the humerus with a knife. By rotating the arm in different directions the muscles attached to the tuberosities can be made tense and divided. If it is absolutely necessary to remove the head of the

Fig. 668. Incision for amputation at the shoulder-joint.

humerus, the joint is opened. Otherwise the bone is sawn through at the anatomical neck. Modifications in the matter of skin-flaps may have to be devised to meet special circumstances.

Amputations through the Arm and Forearm.—One standard method may be used for amputating in the upper limb, whether above or below the elbow. It is simple, and gives an excellent stump. The amputation may be described as a circular one, but with equilateral flaps.

Small equilateral flaps are fashioned, usually one anterior and one posterior. The muscles are then divided right down to bone

over the whole circumference (*Fig.* 669). Above the elbow it is best to divide the muscles in two layers, first the biceps and triceps, and, when these have retracted, complete the division of the deeper muscles to the bone. If this is not done, the biceps and triceps will retract far above the level of the other muscles. Having bared the bone or bones, as the case may be, muscles are held out of the way

669. Standard method of amputating in the upper extremity equilateral flaps and circular division of soft parts.

by a suitable retractor* (p. 620) while the saw is in operation. After vessels have been ligatured and nerves shortened, the flaps may be approximated over the cut surface.

Amputation through the Wrist-joint. —Amputation through the wrist-joint is very seldom required, for usually at least some part of the hand can be saved. Considered as an amputation it is a good one, for the inferior radio-ulnar joint is left intact and pronation and supination remain undisturbed. Owing to the considerable dimensions of the lower end of the radius and ulna, flaps of a rather large size are required. Herein lies a difficulty : in those cases in which the amputation is desirable, there is nearly always a decided insufficiency of skin. To circumvent this difficulty it may be wise to turn up a rectangular piece of skin in the corresponding thigh and suture the free edge to the dorsal edge of the skin above the uncovered disarticulation (*Fig.* 670). By adopting this principle it may be possible to cover eventually the ends of the bone with skin from the thigh, and thus preserve the movements of pronation and supination in the stump.

* Very little if any retraction of the soft parts is necessary in the case of the upper arm.

The actual disarticulation presents no difficulty. The wrist-joint is opened and the entire carpus, with the exception of the pisiform, is removed. The styloid processes of the radius and ulna are nipped off with bone forceps. After blood-vessels have been
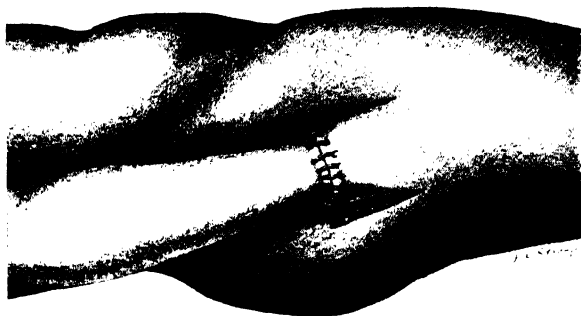
Fig. 670. Disarticulation of the wrist where there is insufficient skin to form a flap to cover the ends of the bones. Method of obtaining a flap from the skin of the thigh.

ligatured, all tendons are shortened, and the median, ulnar, and radial nerves are crushed, ligatured, and divided.

Amputations of the Fingers and Thumb.—*See* LACERATIONS AND MUTILATIONS OF THE HAND (p. 646).

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CHAPTER XXXVIII

GANGRENE

In cases of gangrene we often desire to know more about the blood-supply to the limb than can be revealed by mere inspection and palpation. To amplify this knowledge, which is related so intimately to treatment, attention is directed to the following procedures.

The Fork Test.—Take a dinner fork, examine its prongs, and see that they are level and blunt. With the patient in a good light, draw the fork down the front of the limb towards the gangrenous area. Repeat the process on the inner and outer aspects of the limb. Ask the patient to roll over and again draw the fork down the back of the limb. Vasomotor stripes appear. These can be made plainer by gently rubbing the part with moist gauze. Stripes fading at a certain level indicate the site below which it would be unsafe to amputate.

Visualization of Calcareous Arteries.—A radiograph of the upper part of the thigh is taken. If calcareous arteries are clearly visible, it is usually unwise to perform an amputation below the knee. Sometimes the pain caused by a dying member is intense, and if we can clarify our minds as to the state of the circulation in the limb, it is possible to spare the patient the tedium of awaiting a line of demarcation. In this connection these two tests are particularly helpful.

Senile Gangrene.—If the tests show that the circulation above the gangrenous area is such that reasonably prolonged life in the distal half of the limb is improbable, high amputation—e.g., through the middle third of the thigh—is usually to be advised. This statement, of course, only applies when the patient himself is comparatively hale.

If the tests indicate that it is possible for the parts immediately above the gangrenous area to survive, the following procedures may be adopted.

The Gangrenous Area is Dry.—If only one or two toes are involved, the foot is painted with alcohol, which is allowed to dry thoroughly. It is then powdered with boric acid, covered with gauze, wrapped in cotton-wool, and lightly bandaged. If the pain is not intolerable and the parts remain aseptic, spontaneous amputation of the dead portion is awaited hopefully.

Completely dry—that is, aseptic—gangrene is somewhat infrequent in the hospital class. By the time the patient is admitted there is usually some infection at the base of the gangrenous toe. It cannot be called moist or spreading gangrene, but it is certainly not aseptic. These patients do not do well if treated expectantly. I have had some success by employing the following method. Under local anæsthesia the femoral vein is exposed and ligatured; the gangrenous toe or toes are disarticulated at the metatarso-phalangeal joint; the wound is left open, the interior being thoroughly smeared with B.I.P.P. Alternatively, when there is a reddened area about the base of the gangrenous toe which might foretell spreading gangrene, the femoral vein is ligatured under local anæsthesia and we await developments; if at the end of two or three days the parts about the base of the toe appear to be less rather than more inflamed, the toe is disarticulated under gas and oxygen anæsthesia. The following is an instance showing an unusually favourable result.

Fig. 671. Infected senile gangrene. Amputation performed through the middle third of the thigh.

W. T., aged 71, five weeks previously had pain in his right foot. Three weeks before being admitted to hospital he noticed a discoloration of the toes of the right foot. On examination, the second, third, and fourth toes were dead and black. There was an area of inflammation extending for one inch on the dorsum of the foot and a little pus was exuding from the base of the third toe. Under local anæsthesia the femoral vein was ligatured in Scarpa's triangle. The foot was then washed with alcohol and wrapped up. Three days later there was some improvement in the local condition. Under gas and oxygen anæsthesia the three gangrenous toes were disarticulated. The wound healed slowly and he was able to return home.

E. S. 41

In more advanced cases, where the gangrene has involved the foot but is comparatively aseptic, the question of the advisability of performing a low amputation may be considered. My experience is that sympathectomy is useless when the arteries are calcareous.

The Gangrenous Area is Moist and Spreading (*Fig.* 671).—The only form of treatment which can be recommended is amputation through the middle or lower third of the thigh (*see* p. 625). This same measure will be indicated also in those few cases where local amputation has not met with success.

Diabetic Gangrene.—When the patient has diabetes a physician must be consulted. If the gangrene is not spreading rapidly, usually it is advisable to delay operation until the diabetes has, in part at least, been controlled by insulin. The principles involved do not differ materially from those of senile gangrene, except that a general anaesthetic is always contra-indicated and necessary operative measures are carried out under spinal anaesthesia.

Fig. 672.—Incision in the case of a run-over accident with oedema threatening the circulation of the foot. Timely incision through the swollen tissues may avert amputation.

Threatened and Actual Gangrene from Injury.—The limb has been injured ; typically, a wheel of a vehicle has passed over it, and there may or may not be a fracture. There is a subcutaneous effusion in the region of the injury which is impeding the circulation. The foot is cold and mottled. If rest and warmth do not restore the circulation within an hour, we should assume that the effusion is compressing a main artery and take steps accordingly. A long incision through the deep fascia is indicated (*Fig.* 672). It is well to cleanse the skin and prepare it with alcohol while awaiting the

result of expectant measures. An incision releasing tension may allow the artery to function once more. In other cases where the main artery is permanently damaged no improvement follows and amputation becomes necessary.

An 11-year-old boy was brought to hospital, a wheel of a motor-car having passed over the middle third of his left leg. There was some bruising of the skin, which was intact. X rays showed that there was no fracture, and he was allowed to go home. Four and a half days later he returned. The foot was quite cold and the great toe was assuming a black tinge. The foot was lifeless. I amputated at the modern seat of election. On dissecting the specimen it was found that the posterior tibial artery had been torn across, and there was a hæmatoma in the neighbourhood of the anterior tibial artery. With these exceptions there was no gross damage.

Embolic Gangrene.—Threatened embolic gangrene has already been referred to at some length in discussing EMBOLECTOMY (p. 750). Twenty-four hours after the embolus has lodged, gangrene is inevitable, and amputation must be performed forthwith. The fork test is helpful in determining the site at which amputation should be carried out. Spinal anæsthesia is the method of choice.

Rarer Forms.—Some of the rarer forms of gangrene may be treated by purely local amputation, such as those due to carbolic acid, scleroderma, and typhus. Regarding the last condition, Kagan, after a large experience in Russia, found that high amputation was unnecessary.

In other rare forms of threatened gangrene sympathectomy may be called for. In Raynaud's disease, for instance, I have had some success with this measure. Further comment on these cases is out of place here.

Treatment of Threatened Frostbite.—The part must be gradually thawed, for sudden vasodilatation favours thrombosis. The patient is conveyed to a room with a very small fire. The threatened extremity is rubbed with snow or ice. Afterwards it is gently massaged with a cloth wrung out in cold water. If signs of circulation reappear, the temperature of the room is raised to 50° C. The atmosphere should remain at this temperature until the vitality of the member is assured; the patient is then wrapped in blankets and put to bed. He is given hot drinks, but alcohol should be forbidden.

If after two or three hours there is no sign of the circulation's returning, the part is dried, dusted with boric powder, and wrapped up in a sterile packet. As soon as it is convenient, and we are assured of the area of inevitable gangrene, amputation is performed at a suitable site above this level.

R. W., aged 31, had been on a Polar expedition. In the extreme north of North America, during the return journey, the right hand had become

frost-bitten. His shipmates rubbed the hand with snow. Gradually the circulation of the hand and thumb returned, but three fingers remained dead. When I saw him there was moist gangrene of the middle finger, with a line of demarcation near the proximal interphalangeal joint, but the remaining fingers had recovered their vitality. Total amputation of the gangrenous finger was performed.

GAS GANGRENE

In civil life gas gangrene is comparatively rare. When it does occur it is usually a complication of a compound fracture.

A woman of 46 was admitted to hospital from an outlying district. Seven days previously she had fallen downstairs and sustained a compound fracture of the tibia. This had been dealt with by excision of the wound, suture, and splinting. On admission the temperature was 104°, the pulse 108, her complexion muddy. The leg was inflamed below the knee. A little thin pus was oozing from the wound, and faint crepitations could be distinguished on testing. A diagnosis of gas gangrene was made. Amputation was performed in the middle of the thigh, the wound being partially closed. Hydrogen peroxide was then injected into the subcutaneous tissues of the thigh, using an aspirating syringe. Eighty c.c. of anti-gas-gangrene serum was administered. Bacteriological examination of the pus showed *B. welchii*, streptococci, and staphylococci. The serum was repeated in doses of 80 c.c. for four days, the dose being gradually reduced by 10 c.c. daily for a week. Recovery followed.

Prevention.—If a prophylactic dose of anti-gas-gangrene serum were administered at the time of the treatment of the wound, doubtless the incidence of gas gangrene would be considerably reduced.

Treatment.—Amputation is often the best course in the cases which occur in civil life, but it must be understood that if the limb is not irreparably damaged and the patient is comparatively young, the lessons of war should be applied to the cases of peace.

Gas gangrene is chiefly a disease of muscle, and it is rare to meet the condition without muscle injury. In its early stages the lesion may be described as a longitudinal one, for it appears to run up and down the wounded muscle. Certain muscles, or groups of muscles, are involved, while others escape, and macroscopically the muscle may be seen in a condition of what is known as 'red death' or 'black death' (*Fig.* 673). During the European War gas gangrene was treated very successfully by excising an affected muscle or group of muscles. The muscles in the neighbourhood of the wound are exposed by an ample longitudinal incision and the affected muscle is excised until a portion presenting normal colour is reached. Here the muscle is cut across. If contractility is observed and the cut surface of the muscle bleeds, it is evident that healthy tissue has been reached.

Providing that a limited group of muscles is alone affected,

excision offers a prospect of saving the limb. If several groups are involved, amputation is preferable to devastating the limb.

At the conclusion of any operation for gas gangrene, injection of hydrogen peroxide into the subcutis and the stumps of divided muscles is definitely beneficial. The injection should be done systematically, and great care must be taken to avoid entering a vein,
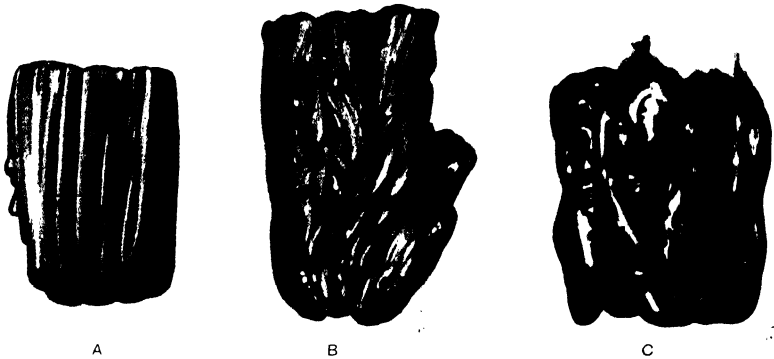
Fig. 673. Gas gangrene. A, Normal muscle; B, 'Red death'—note the cavitation by bubbles of gas; C, 'Black death'. (After Sir Cuthbert Wallace.)

for by so doing an air embolus might follow from the bubbles of oxygen.

Dressings are reduced to the absolute minimum, allowing free access of air to the wound, which may be irrigated by the Carrel-Dakin method.

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CHAPTER XXXIX

LACERATIONS AND MUTILATIONS OF THE HAND

EVERY surgeon is aware of the necessity of conserving the hand. Even the stumps of one finger and the thumb are more valuable to their possessor than an artificial hand (*Fig.* 674).

Fig. 674.—By preserving the thumb and stump of one finger, the patient is left with a useful hand.

THE SKINNED (DEGLOVED) HAND

The patient gets his hand trapped. The skin and nails are torn off—indeed, the skin has been literally ripped off the hand like a glove, and the muscles, tendons, and perhaps the bone, are laid bare. What is to be done?

When the Skin Remains Attached. —If there is a grey, lifeless-looking mass of inverted and perhaps dirty skin hanging by a pedicle, it has been taught, almost universally, that the dying mass should be snipped away, since its blood-supply has been cut off and gangrene is inevitable. Carl Beck, in his monograph *The Crippled Hand*, strongly disparages this teaching, for he has found that if it is cleansed and

replaced skilfully, the whole or greater part of the skin survives. Therefore, when confronted by this problem, excise lifeless pieces of

Fig. 675. A degloved hand embedded in the subcutis of the thigh.
(*After Schroeder.*)

muscle and fascia, wash the whole area with a mild antiseptic solution such as flavine or mercurochrome, and endeavour to replace the skin. If there is much contamination, strips of rubber drainage should be inserted at appropriate intervals through the suture line. The whole hand should be enveloped in a dressing soaked in saline, and the bandaged hand must be kept warm by hot bottles. If infection follows, a portion of the skin sloughs, and within certain limits the defect may be made good by grafting by Thiersch's method after infection has abated.

When the Skin is Lost. — After thorough cleansing, immediate implantation of the hand into the subcutaneous tissue of the thigh (*Fig. 675*) may obviate the necessity for immediate or

Fig. 676. Plastic surgery of the degloved hand. Condition at an early period after operation. (*By kind permission of 'The British Journal of Surgery.'*)

remote amputation. This operation is in its infancy, and although the results cannot be said to be uniformly good, they are encouraging,

and hands or portions of hands have been saved which would other-
wise have been sacrificed.

G. H. Colt's Case.—

A woman of 48 presented herself with a hand entirely denuded of skin
on the dorsal aspect and over the middle three digits and their metacarpal
bones on the palmar aspect. Operation was begun two and a half hours
after the accident. The hand was sterilized with ether and flavine. A
pocket was constructed in the thigh with divergent tunnels for the denuded
fingers. Into the pocket was placed the hand, and the three injured fingers
were drawn into the subcutaneous tunnels from counter-openings. Drain-
age was provided at the lower end of
each tunnel and under the main flap.
After the skin about the wrist had
been approximated to the free edge of
the flap the hand was firmly bandaged
to the side. Drains were removed
on the third day when it was apparent
that there was no gross sepsis. One
month after the original operation
separation of the flaps was commenced.
The fingers were separated one at a
time, the hand being completely freed
on the 45th day. *Fig.* 676 shows the
result obtained in the early stages.
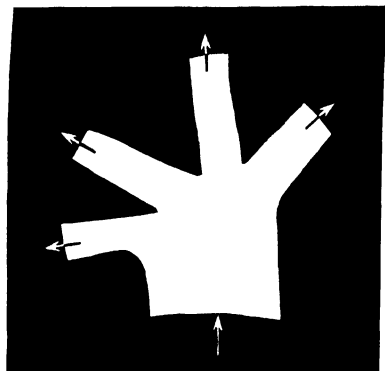
677.— The pattern for a subcu-
tunnel for a degloved hand. The
i for the fingers and thumb
should be made as divergent as possible,
s a fair prospect of saving the
remaining digits, the little finger should
be amputated.

Before commencing the implan-
tation, place the injured hand on
the sterilized thigh so as to make
sure that the pocket will be in the
right place. Construct diverticula
for the fingers as divergently as
possible (*Fig.* 677), so as to yield
the maximal amount of skin for
each finger. Always provide free drainage under the main flap
and for each diverticulum.

REPLACEMENT OF A COMPLETELY SEVERED PORTION OF A DIGIT

Replacement of the Fragment.—The chances of survival of the
autograft are inversely proportional to the length of time which elapses
between the accident and the replacement of the fragment, and also
to the amount of the contamination present. Amazing results are
sometimes met with.

T. G. Hamilton's Case.—

A man, using a slicing machine, severed obliquely one inch of the tip
of his index finger. Profuse bleeding caused much excitement in the shop,
and it was fully half an hour before the fragment was discovered with its
cut surface against a cooked ham. The fragment was washed in saline and
replaced. Healing occurred by first intention.

More painstaking treatment is necessary when the whole of the terminal phalanx is severed.

J. W. Tomb's Case.—

A child of 5 was brought in with the terminal phalanx of the index finger completely severed through the joint with the exception of a narrow strip of skin on the inner side. After cleansing, the fragment was sutured into position, and the mother was instructed that she must remain awake all night to keep the finger continuously immersed in a bowl of warm saline at blood heat. Next morning the tip of the finger was still cold and apparently lifeless. It was kept immersed for a further twenty-four hours. On re-inspection it was evident that the circulation was becoming re-established. The saline bath was accordingly stopped. The fragment survived.

method of repairing a wound with loss of substance
flexor surface of a finger.

It is my experience that happy results are somewhat infrequent. If after forty-eight hours the fragment is becoming mummified or the suture line shows evidence of infection, the fragment must be cut away and the wound, if infected, treated with eusol compresses.

Gatewood's Method of Repairing a Wound with Loss of Substance on the Flexor Surface of the Finger.—This method is very useful, and *Figs.* 678, 679 makes the principle clear. The difficulty of approximating the flap to the finger can be overcome by inserting all stitches before they are tied. The resulting defect on the thenar eminence can be closed for the most part by interrupted sutures.

AMPUTATION OF A FINGER

As opposed to the thumb, where it is always the first duty of the surgeon to save every millimetre, a well-planned total amputation of one finger leaves the patient with a hand which after a little practice is practically unimpaired. A stump of a finger is an eyesore to the beholder, while the absence of a finger passes unnoticed. When deciding whether to perform partial or total amputation of the finger the patient's work is taken into consideration, but there are few walks of life where the loss of a finger is a handicap. I have lost my own

Fig. 680.—Incisions for disarticulation at the metacarpo-phalangeal joint.

left index finger, and I can state with assurance that its absence is no hindrance.

Amputation of a single finger with the head of the metacarpal bone, if performed correctly, is, I believe, preferable to amputating a large portion of the finger. This is certainly true in the case of the skilled worker. The doctrine that the loss of the head of the metacarpal bone seriously weakens the hand is pure fiction. Soon after a complete amputation of the finger the patient forgets his loss except when buying ready-made gloves.

Total Amputation of the Index and Little Fingers.—The opera-
tion strongly recommended is
Faraboeuf's—that is, by a
lateral flap.

We will consider the
index finger. Commence the
incision over the dorsal sur-
face of the neck of the meta-
carpal bone. Sweep round in
a curved manner to a point
on the palmar surface dia-
metrically opposite the com-
mencement, the flap extending
about a third of the way up
the proximal phalanx. Dissect
down this flap. Encircle the
base of the finger with an
incision passing through the
first interdigital cleft (*Fig.*
680). Now disarticulate the
finger. After securing blood-
vessels, clear the neck of the
metacarpal bone. Place the
hand flat upon a side table

*Fig. 681. Showing the method of sectioning
the bone in total amputation of a finger. In
the cases of the index and the little fingers the
bone is severed obliquely. In the middle and
ring fingers the metacarpal bone is divided
straight through the shaft.*

and put a pad of gauze beneath the hand. Using a broad chisel,
neatly and obliquely re-
move the head and neck
of the bone (*Fig.* 681).
Suture the flap into posi-
tion accurately. Some-
times it happens that
there is rather too much
skin, in which case trim
the flap before suturing.
The result of this ampu-
tation is one of the most
pleasing in surgery (*Fig.*
682).

**Total Amputation of
the Middle and Ring
Fingers.**— Sherwood's
amputation is a distinct
advance on older meth-
ods, for reconstructing

*Fig. 682. Result of amputation of the index finger
with excision of the head of the metacarpal. The U
shaped flap was used.*

the interdigital cleft results in leaving the patient with a most natural-looking hand. Inspect the webs on either side and select one to be preserved. Have the hand held in the manner shown in *Fig.* 683. Commence the incision on the doomed finger to one side of the cleft to be preserved (*Fig.* 684), and sweep down on the dorsal surface to about the middle of the metacarpal bone. Make a corresponding incision on the other side, only this time commence the incision at the base of the sound finger. Now turn the hand over and join the extremities of the incision in the form of a v (*Fig.* 685). Return to the dorsum. Flex the joint strongly. Cut through the dorsal expansion, open the
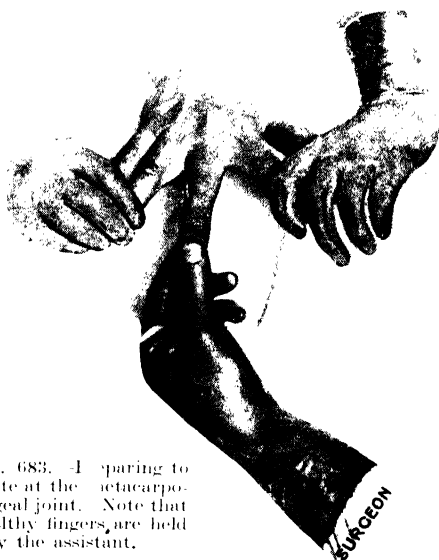
Fig. 683. —Preparing to amputate at the metacarpo-phalangeal joint. Note that the healthy fingers are held aside by the assistant.

joint, and disarticulate the finger. Having attended to bleeding points, proceed to clear the upper part of the metacarpal bone, and remove the distal half, or rather more, with bone forceps (*see Fig.* 681). The skin edges are now sutured accurately into position. The interdigital cleft is thus brought into its new position. The hand is bound to a splint the same width as the narrowed palm.

An important detail in the operation is the removal of the v-shaped wedge on the palmar aspect (*Figs.* 685, 686) which prevents the bulging pad which is so much in evidence after the usual racket removal of a finger. This pad, which is rich in nerve-endings, when

Figs. 684, 685. — Amputation of the ring or middle finger with reconstruction of the interdigital cleft (Sherwood's method).

Fig. 686. — End-result of a total amputation of the middle finger. The patient suffers no inconvenience.

subjected to any pressure, calls up a stiff, electrified ghost of the missing finger, a fault which is eradicated completely by employing Sherwood's technique.

Amputation of a Terminal Phalanx. When a terminal phalanx is mangled, disarticulation at the distal interphalangeal joint is indi-
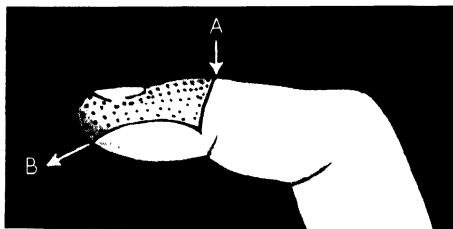
Fig. 687.—Amputation of the terminal phalanx. An incision is made at **A** and the joint opened. After turning the knife through a right angle the manoeuvre is continued until the blade emerges from **B**.

cated. The well-known classical method of removing the terminal phalanx by introducing a narrow-bellied finger-knife into the joint from the dorsal aspect and cutting so as to form a palmar flap (*Figs.* 687, 688) is very seldom applicable, for the pulp of the finger is crushed.
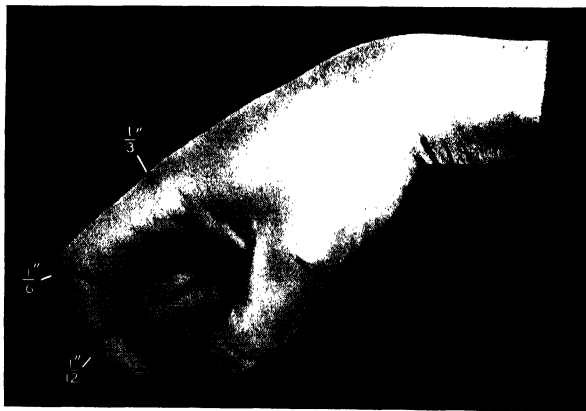
Fig. 688.— It is important to realize that the joint lies $\frac{1}{3}$, $\frac{1}{6}$, and $\frac{1}{12}$ of an inch *distal* to the corresponding eminence or knuckle.

On the other hand, small palmar and dorsal flaps of undamaged skin can usually be dissected up. If after disarticulation it is found that the flaps are too short to cover the ends of the bone, the head of the phalanx can be nipped off with bone forceps.

Amputation at the Proximal Interphalangeal Joint or through the Shaft of the Second Phalanx.—As amputation at these sites is invariably necessary because of a crushing accident, no precise details can be given for cutting flaps. One simply fashions flaps of sufficient dimensions to cover the end of the bone from any available healthy skin. If these prove to be inadequate, a suitable portion of bone must be removed with bone-cutting forceps. It is desirable to find the flexor and extensor tendons and to suture them together over the bone-end before closing the skin. For reasons stated already, total removal of the finger is often to be preferred to partial amputation.

MUTILATIONS OF THE THUMB

The importance of the thumb as an integral part of Nature's pincers for grasping objects makes it imperative to conserve every portion possible.

Fig. 689. The hand of a patient who severed his thumb. The stump, which

Even if we can only save a small part (*Fig.* 689) we have performed a great service to the patient.

In the endeavour to preserve as much as possible, denuded bone, if not grossly contaminated, may be covered by a flap from the chest or

Figs. 690, 691. —Covering protruding bone with a flap taken from the skin of the chest or elsewhere.

elsewhere. The flap is rolled around the bared surface and stitched to the digit (*Figs.* 690, 691). After ten days the pedicle is severed.

To show what conservative surgery will sometimes achieve the following case is quoted : -

T. G. Hamilton's Case.—

Fig. 692.—Avulsion of flexor longus pollicis.

Whilst splitting wood a man severed his thumb completely near the base. It was attached only by some skin near the web. The fragments were cleansed, and the divided flexor and extensor tendons were united. Stitches were also placed through the periosteum so as to co-apt the divided bone. The skin was then united by three sutures. After dressings had been applied the hand was done up with a starch bandage. The soft tissues atrophied and remained thus for a long time, but later they recovered, and for years the man has been working at his trade with very little handicap.

Avulsion of the Terminal Phalanx with the Flexor Tendon.—

An engineer presented himself at hospital with the terminal phalanx of his thumb wrapped in a handkerchief. He stated that he had caught the thumb in revolving machinery. To the severed phalanx eight inches of the flexor longus pollicis was attached (*Fig.* 692). The head of the first phalanx was excised, after which the trimmed ends of the skin could be approximated. A very useful member resulted, for the short flexors of the thumb acted admirably.

NEEDLE IN THE HAND

Never attempt to remove a needle from the hand under short gas anæsthesia. It may require much patience to find the needle, and the operator must not be hurried. Local or full general anæsthesia should be employed.

It is hardly justifiable to undertake to remove the foreign body without a preliminary X-ray examination. In my experience it is more helpful to place the hand under the screen and mark the position of the needle with pen and ink than to have a series of X-ray photographs. Attempting removal in the X-ray room under the fluorescent screen is seldom satisfactory. Asepsis is endangered and groping about in the dark is annoying. Have the hand scrubbed with soap and water and prepared with alcohol *before* the X-ray examination. After the ink which marks the position of the needle on the skin is dry, the hand is immersed in a bowl of iodine and then wrapped in a sterile towel.

When the patient has been anæsthetized, apply a tourniquet above the wrist and place the hand upon a side table and sit down to work. Make the skin incision obliquely over the line of the needle (*Fig.* 693), then commence the search. Usually a probe is passed into the wound and moved about. A muffled 'ping' is heard. Many times have I seen a look of satisfaction on the operator's face turn

to disappointment on finding that it is some tendinous structure which the probe has struck. The following is suggested as a better mode of procedure. Make an incision large enough to allow the insertion of the little finger. Touch-corpuscles will detect foreign bodies when the probe will not. After feeling around systematically

Fig. 693. Incision for removal of a needle in the hand.

with a negative result, mobilize a tendon or muscle by blunt dissection, and holding this aside, introduce the finger once more and feel again. If this is not successful, enlarge the incision and carefully dissect. With a reasonable knowledge of anatomy nothing of importance will be damaged and the needle must surely be found.

Severed Tendons in the Hand.—*See* p. 613.

Severed Nerves in the Hand. *See* p. 608.

Palmar Hæmorrhage. *See* pp. 558, 560, 670.

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CHAPTER XL

INFECTIONS OF THE HAND

INFECTIONS of the hand present one of the most important chapters in emergency surgery. The treatment of suppuration in the palm has only comparatively recently emerged from a chaotic state, thanks to the researches of Kanavel. Correct treatment here, as elsewhere, rests largely on correct diagnosis, and accurate diagnosis of the location of pus in the hand never comes as a surgical intuition. The treatment of severe infection of the hand is one of the few exceptions where theoretical knowledge is even more important than practical experience.

When confronted with a *serious hand infection* the first thought should be : " Is this a case of (*a*) lymphangitis, (*b*) tenosynovitis, or (*c*) fascial space infection ? " Each is a clinical entity capable of precise diagnosis. Because (*b*) is usually the result of (*a*) it is not likely to occur within the first forty-eight hours. A weighty problem to decide is the differential diagnosis between (*a*) and (*b*).

LYMPHANGITIS

Organisms, almost always streptococci, gain entrance through an abrasion which may be minute. A portion of the hand immediately adjacent becomes swollen and painful, and there is often considerable elevation of the temperature. Later red streaks, so characteristic of lymphangitis, can be seen coursing up the arm. It is of cardinal importance to distinguish lymphangitis from suppurative tenosynovitis and fascial space infection. The two latter conditions require urgent operation, while in lymphangitis, at any rate in its early stages, incision is highly mischievous.

SUPPURATIVE TENOSYNOVITIS

Suppurative tenosynovitis is a condition of great urgency. Effective drainage must be instituted at the earliest possible moment. To delay is to sacrifice a finger, a hand, or maybe a life. The tendon-sheaths are depicted in *Fig.* 694.

General Operative Procedures.—For urgent operations on the hand gas and oxygen anæsthesia is ideal. Failing this an ordinary general anæsthetic may be administered. Raise the arm for three minutes and apply a tourniquet above the wrist. Now place the hand upon a small table and sit down to operate. Small incisions tend to become

closed by œdematous tissue. It is advisable not to make the incision
in the middle line of the sheath but to one side of it, as is shown in
Fig. 696. The middle line is avoided in order to lessen the tendency
of the tendon to prolapse. If there is pre-operative clinical evidence
that a lumbrical canal is involved, this side will be chosen for the
incision.

In cases of some standing, as soon as the tendon-sheath is dis-
played, pus can be seen distending the theca, but in early streptococcal
infections the tendon can be seen shining through an almost trans-
parent sheath, and one feels reluctant to proceed. If a clinical
diagnosis of tendon-sheath infection has been made, it is essential to
continue. The tendon-sheath should be opened within the limits
of the incision. When frank pus is present pay particular attention
to the condition of the tendon. If it has a dull, yellow appearance,
it will surely slough, and much time can be saved by excising it. If
it is *merely* excised, the infected upper end will retract and carry
infection into the palm. To prevent this calamity fix the cut ends of
the tendons to the periosteum of the proximal phalanx by a catgut
stitch which will hold them until protective adhesions have formed.

In fulminating cases of suppurative tenosynovitis the œdema is
occasionally so pronounced that the blood-supply to the digit is cut
off, and gangrene is imminent. As the œdema increases so the pain
decreases. Such cases require immediate disarticulation at the meta-
carpo-phalangeal joint. When this is done the end of the cut flexor
tendon must be stitched to the edge of the wound, which is left open.

The Index Finger. The sheath is opened on the radial side
(*Fig.* 696), unless it has been shown at the clinical examination that
the lumbrical canal between the index and middle fingers is involved,
when the ulnar side is selected. Should pus ooze out on pressure
over the lumbrical canal between the first and second fingers, then
this lumbrical canal is drained best by splitting the web as far as the
distal palmar flexion crease. If the radial side of the sheath has
been opened, pressure is exerted over the thenar space. When pus
exudes from the thenar space drain that space (*see* p. 673). Bear in
mind the possibility, but great rarity, of infection of the middle palmar
space from the index flexor tendon-sheath.

The Middle Finger. — Decide whether the lumbrical canal on the
radial or the ulnar side is the more tender. *In doubtful cases choose
the ulnar side*. If the ulnar side has been chosen and pus can be
made to well out of the lumbrical canal, carry the incision downwards
to the distal palmar flexion crease (*Figs.* 695, 696). In early cases
the middle palmar space is not involved : *the pus lies between the flexor
tendon and the palmar fascia*, and a palmar extension of the original
incision is all that is required.

If at the clinical examination it has been decided that the middle palmar space is infected, drain that space (*see* p. 675). In involvement
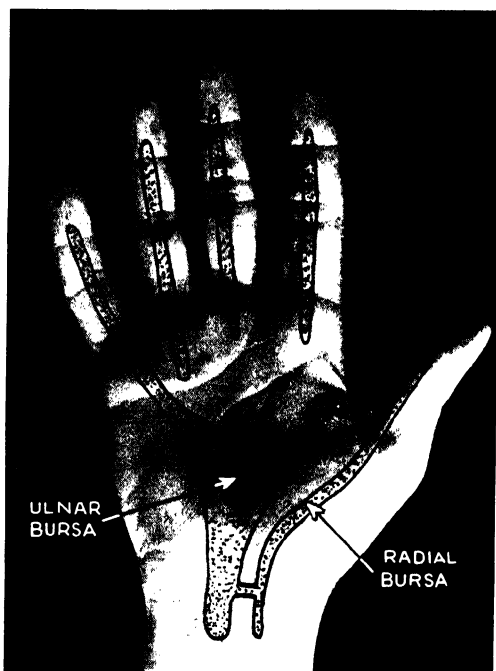
Fig. 694.—The flexor tendon-sheaths of the hand.

Fig. 695.—Suppurative tenosynovitis of the middle finger. The tendon-sheath has been laid open.

of the lumbrical canal on the radial side, remember the possibility —but great rarity—of thenar space infection.
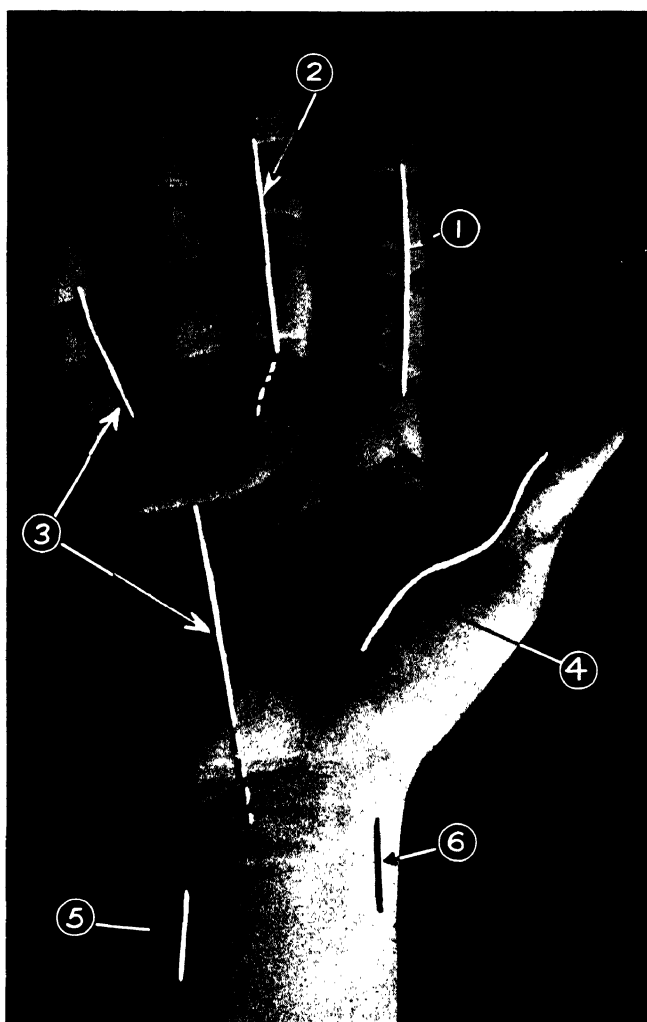
Fig. 696.—A symposium of incisions for draining infected flexor tendon-sheaths. 1. Usual incision for opening an infected tendon-sheath. 2. When a lumbrical canal is infected in addition the incision is prolonged into the appropriate eb space. 3. Incisions for opening an infected ulnar bursa. 4. Incision for opening an infected radial bursa. 5. Incision for opening forearm from the hand. 6. Counter-incision used in the cas forearm: from the radial bursa.

The Ring Finger.—The remarks concerning the middle finger apply to the ring finger also, with the exception that if in doubt as to which side to open the sheath, choose the radial side. The palmar extension for draining the lumbrical canal applies here also.

The Little Finger and the Ulnar Bursa.—The flexor tendon-sheath of the little finger does not always communicate with the ulnar bursa. Anatomists report that a channel exists in 50 per cent of cases, but clinical experience reveals a continuity of the fifth tendon-sheath and the ulnar bursa considerably more often than not (*Fig.* 697).
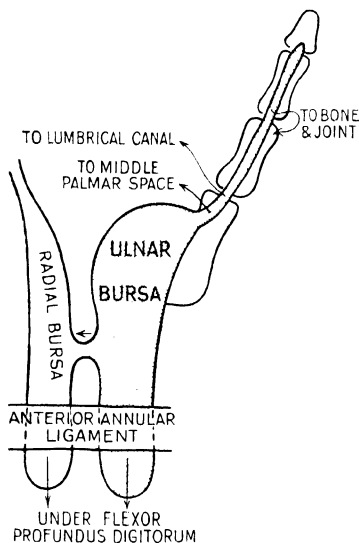
Fig. 697.—The connections of the ulnar bursa. (N.B. The ulnar bursa is the palmar bursa of British anatomy.)

Fig. 698. Kanavel's sign for ulnar bursitis point of maximal tenderness in the site marked with a cross.

Special Clinical Features of Ulnar Bursitis.—There is much œdema of the back of the hand. There is a fullness of the palm, but concavity is still present. Usually swelling is well marked above the anterior annular ligament. Kanavel's sign is present (*Fig.* 698); this sign passes off in a few days. A communication exists between the radial and ulnar bursae in 80 per cent of cases. If the ulnar bursa is not drained effectively at an early stage, the radial bursa becomes involved also. Thus, if in the course of an ulnar bursa infection the thumb becomes fixed and tender, we may be tolerably certain that the radial bursa is infected too.

Treatment of Suppurative Tenosynovitis of the Little Finger.— Make an incision on the ulnar side of the sheath over the two

proximal phalanges (*Fig.* 699). When the tendon-sheath is occluded from the ulnar bursa, a fortunate but rare event shown by limitation of tenderness to the fifth sheath, the incision is confined strictly to the finger.

Treatment of Ulnar Bursa Infection.—Having made the above incision, exert pressure over the palmar portion of the bursa. A purulent exudate welling up from the inferior end of the wound makes an ulnar bursal infection indisputable. Make an incision from the distal flexion crease towards the base of the palm along the centre of the hypothenar eminence, inclining rather to the radial side (*Fig.* 699).

A pad of œdematous fat will be seen to bulge in the wound. Dissect away this fat. Pass a director into the bursa from the sheath above and lay open the bursa, cutting as near to the ulnar side as possible. When the anterior annular ligament is reached, exert pressure over the prolongation of the bursa in the forearm. Usually pus is present here as well. Cut the anterior annular ligament. Now drain the forearm in the manner described on p. 668. Consider the advisability of draining the radial bursa, remembering that the two intercommunicate in 80 per cent of cases (*see Fig.* 694). As a general rule, if the infection has been present for more than forty-eight hours and there is flexion and rigidity of the thumb, one should have no hesitation in opening the radial bursa.

Fig. 699. Incisions for draining suppurative tenosynovitis of the fifth digit complicated by ulnar bursitis.

A fishmonger, aged 48, was groping in a storage tank when the sharp dorsal fin of a fish pierced his little finger. Two days later, when he reported at hospital, he was obviously extremely ill his temperature registering 103·4 . All the fingers were flexed, but the little finger resisted extension and was more swollen than the remainder. There was a puffy swelling above the wrist, which was tender. The thumb resisted extension, and great pain was caused when extension was attempted. The fifth tendon-sheath, the ulnar bursa, the radial bursa, and the forearm were drained. Antistreptococcal serum was administered. Progress was slow. The tendon of the little finger was excised as it was sloughing. After this progress was more rapid. The end-result was satisfactory, particularly after the little finger had been amputated, which was done one month after all the wounds had healed.

The Thumb and the Radial Bursa.—The radial bursa (*Fig.* 700) is the extension of the sheath of the flexor longus pollicis. The

tendon-sheath begins at the base of the distal phalanx of the thumb. It passes through the thenar eminence under the anterior annular ligament, where it ends, its blind extremity resting upon the pronator quadratus and under the flexor profundus digitorum.

Clinical Features of Tenosynovitis of the Flexor Longus Pollicis. — Flexion of the distal phalanx of the thumb, with rigidity and tenderness over the sheath, and maximal swelling just above the anterior annular ligament, combine to make a classical picture of suppurative tenosynovitis of the flexor longus pollicis.

TO SURFACE

TO THENAR SPACE (*Rare*)

TO JOINT & BONE

RADIAL BURSA

ULNAR BURSA

ANTERIOR ANNULAR LIGAMENT

UNDER FLEXOR PROFUNDUS DIGITORUM
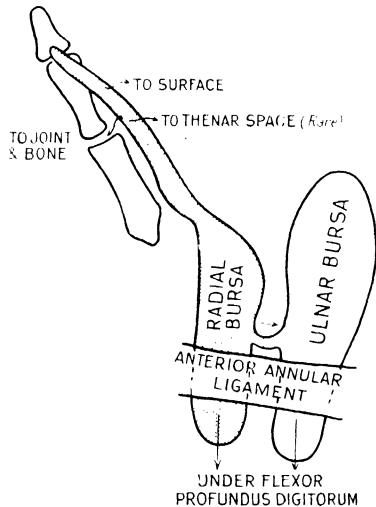
Fig. 700.—The connections of the radial bursa. (N.B. The radial bursa is the sheath of the flexor longus pollicis.)

Fig. 701. An end-result of combined infection of the radial and ulnar bursae. There is considerable deformity, but with education the hand became very useful.

The reader's attention is directed specially to the communicating channel between the radial and ulnar bursae. It cannot be emphasized too strongly that in early secondary involvement of the ulnar bursa from the radial there is no gross swelling of the palm. If there is even a suspicion of ulnar bursal complication in a case of radial bursitis which has persisted more than forty-eight hours, both the radial and the ulnar bursae should be laid open at the same time (*Fig. 701*).

Operative Technique.—Somewhat on the radial side of the front of the proximal phalanx dissect down upon the tendon of the flexor longus pollicis. Follow the sheath through the thenar eminence, separating the muscular masses, the short thenar muscles, which form

the eminence (*Fig.* 702). The tendon lies nearer the palm than one is inclined to think. The dissection is carried down to within a
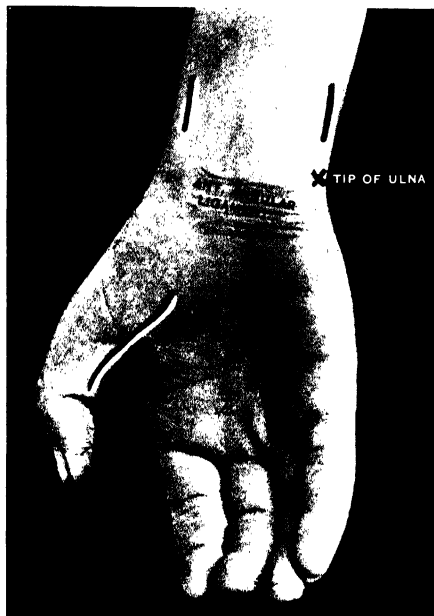
Fig. 702. Incisions for drainage of suppurative tenosynovitis of the flexor longus pollicis complicated by radial bursitis.

Fig. 703. Infection of the forearm via the radial bursa in an infected lacerated wound of the thumb. The incision for draining the forearm is shown (**A**), and also the proposed incision for opening up the sheath of the flexor longus pollicis.

thumb's breadth of the anterior annular ligament, but no farther, for the motor nerve to the thenar muscles crosses the sheath between this point and the anterior annular ligament.

Drainage of the radial bursa is carried out by the ulnar forearm method (*see below*), supplementing it with a counter-incision on the radial side (*Figs.* 702, 703).

In severe infections and delayed cases primary removal of the tendon of the flexor longus pollicis should receive consideration. This tendon is particularly liable to die and remain for weeks causing the infection to persist, jeopardizing other structures. The loss of the tendon is to be preferred to the loss of the motor nerve to the thenar eminence.

Removal of the Whole Tendon of the Flexor Longus Pollicis. — Having laid open the tendon-sheath as far as a thumb's breadth from the anterior annular ligament, direct your attention to the anterior surface of the wrist, and here make an incision a quarter of an inch to the radial side of the middle line. Dissect on the radial side of the flexor sublimis digitorum. Pass a probe along the tendon-sheath until its end is identified in the forearm, and by its aid find the flexor longus pollicis in the forearm. Detach the tendon at its insertion and pull it through until it appears in the forearm. The tendon is pulled down until its muscle belly appears. This is transfixed with a stitch, which anchors the muscle in the wound (*Fig.* 704). The tendon is then cut away.
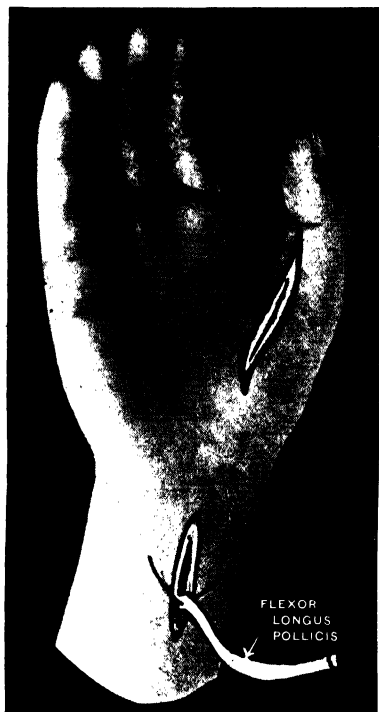
Fig. 704. — Excision of the tendon of the flexor longus pollicis.

FLEXOR
LONGUS
POLLICIS

INVOLVEMENT OF THE FOREARM FROM THE HAND

Kanavel's injection experiments have proved conclusively that in rupture of the radial and ulnar bursæ the spread of pus to the forearm occurs along the plane between the flexor profundus on the one hand, and the pronator quadratus and interosseous membrane on the other (*Fig.* 705). It is in this deep plane that pus first tracks up the arm, and only late in the course of the disease does it become more superficial. Utilizing this knowledge, drainage of the forearm in infections from the hand can be carried out with precision (*Fig.* 706).

FLEXOR PROFUNDUS

ULNAR VESSELS
AND NERVE

MEDIAN NERVE

RADIAL VESSELS
AND NERVE

ULNA

RADIUS

PUS
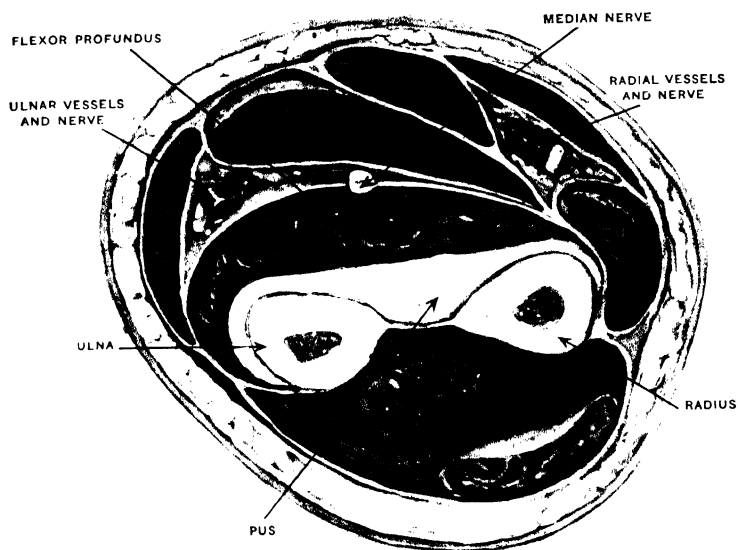
Fig. 705. Transverse section of lower forearm, showing pus spreading from the palm. It passes up the forearm, under the flexor profundus digitorum, between this muscle and the pronator quadratus and interosseous membrane.

FLEXOR
PROFUNDUS
DIGITORUM

ULNAR ARTERY
AND NERVE

MEDIAN NERVE

RADIAL
ARTERY

PRONATOR
QUADRATUS

RADIUS
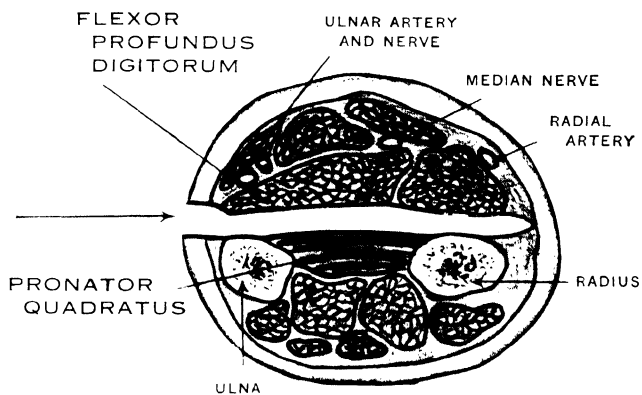
ULNA

Fig. 706. Cross-section of the lower forearm to show the plane in which pus spreads from the hand to the forearm. Drainage is effected from the ulnar side between the flexor profundus digitorum and the pronator quadratus.

Drainage of the Forearm in all Infections of the Forearm from the Hand (*Fig.* 707).—Palpate the styloid process of the ulna, and commence the incision 1½ in. above this point, the better to avoid the radial artery on the radial side. The incision is made on the flexor surface of the ulna and passes right down to the bone (*see Figs.* 699, 703). It is at least two inches long. A hæmostat is thrust across the flexor surface under the flexor tendons and the jaws are opened. If the radial bursa is involved, make a counter-incision on the radial side (*see Fig.* 702). The finger is passed into the incision and the flexor
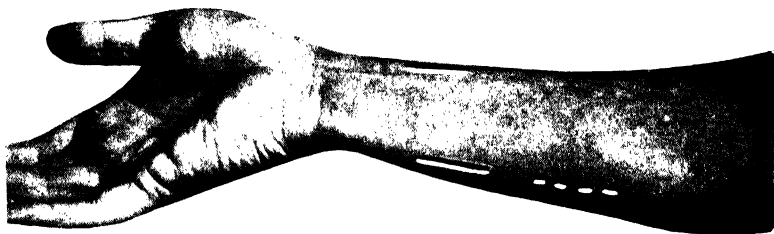
Fig. 707. Infection of the forearm from the palm. Incisions for draining the space beneath the flexor tendons. The dotted line shows the position of the incision when it is found that the pus has extended far up the forearm.

tendons are sought. If the tendons are not at once apparent, flexion and extension of the fingers will reveal them, and the exploring finger passed deep to them comes to lie on the interosseous membrane. In the case of the radial bursa a hæmostat is passed from the palmar incision until its beak is felt by the exploring finger. The distal end of the radial bursa is ruptured thoroughly. The same procedure is adopted in the case of the ulnar bursa. A drainage tube is unnecessary.

AFTER-TREATMENT OF SUPPURATIVE TENOSYNOVITIS

At the conclusion of an operation for a serious hand infection give an intravenous injection of mercurochrome. In the case of infections of tendon-sheaths, immediately after operation apply a malleable dorsal splint bent at the wrist so as to hyperextend the hand. This prevents prolapse of tendons and mitigates dropped wrist.

First Day.—Assuming that the operation has been done in the evening, on the following morning hot saline baths are begun, an arm-bath being almost a necessity (*Fig.* 708). The baths are continued for two hours at a time, with three-hourly intervals, during which time gauze soaked in paraffin is applied. In the evening a large magnesium sulphate fomentation is applied, hyperextension being maintained by splinting, and morphia ordered if the patient is not sleeping.

Second Day.—The same routine is followed.

Third Day.—The hand is examined closely, and if it looks sodden, only one bath is ordered. The sister in charge of the case is asked to put on gloves and gently move the fingers in the bath. She is
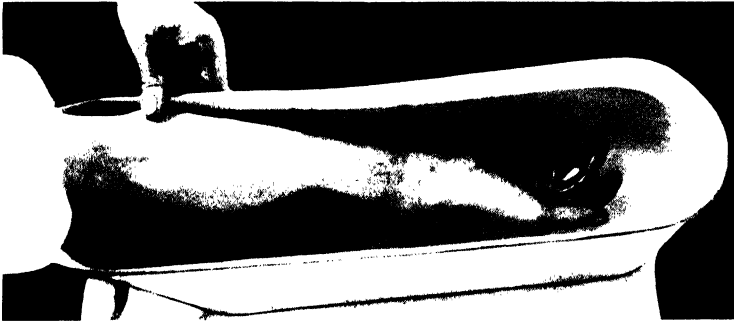
Fig. 708. Arm-] ... ous infe

requested not to squeeze the   in order to try and express pus while dressing the wound.

Fourth Day.—Saline baths are stopped. I have tried a bath of liquid paraffin with some success. The pus falls to the bottom and can be removed. The paraffin can be used over and over again. This is a good medium in which the patient may practise moving the fingers.

Fifth Day. Usually the magnesium sulphate fomentations at night are stopped and a paraffin dressing is substituted. Artificial sunlight is applied to the arm and hand. If the wounds are malodorous, hydrogen peroxide instillations, followed by irrigation with eusol, are recommended.

SOME COMPLICATIONS NOT CONSIDERED ALREADY

In all serious infections of the hand, after the fifth day an X-ray should be taken. If *necrosis* of the phalanges (*Fig.* 709) is present, eventual amputation of the digit is to be recommended. It is unwise to amputate before the infection has abated.

Fig. 709.—Skiagram of a case of suppurative tenosynovitis of the index finger complicated by necrosis of a phalanx.

One tendon-sheath may become involved from another via the lumbrical canals.

Sloughing tendons should be excised. In cases of prolonged suppuration of the upper wrist it is probable that a tendon or tendons are sloughing beneath the anterior annular ligament.

Secondary hæmorrhage in the palm or at the wrist should be treated by ligature of the brachial artery.

INFECTIONS OF THE FASCIAL SPACES

There are seven fascial spaces where pus can accumulate : (1) The pulp space ; (2) The thenar space ; (3) The middle palmar space ;

DORSAL SUBAPONEUROTIC
DORSAL SUBCUTANEOUS　　SPACE
SPACE　　　　　　　　　EXTENSO COMMUNIS
DIGITORUM

FLEXOR TENDON IN SHEATH
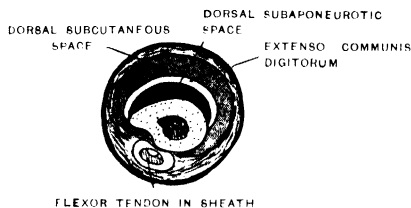
Fig. 710.—Cross-section of a finger showing the relationship of the dorsal subcutaneous and dorsal sub-aponeurotic spaces. These spaces are continued downwards on to the back of the hand, bearing the same relationship to the extensor tendon.

(4) The dorsal sub-aponeurotic spa

Fig. 711.—Too often the back of the hand is incised when pus lies in the palm. Œdema of the dorsum, which is often present in infections of the hand, gives rise to a swelling which pits on pressure.

(5) The lumbrical spaces (four in number) ; (6) The dorsal subcutaneous space ; (7) The hypothenar space. The first five are dealt with in detail below. The last two do not require the same individual attention, and will be dismissed briefly.

The Dorsal Subcutaneous Space allows pus to escape all over the hand. Its relationship to the dorsal sub-aponeurotic space is shown in *Fig.* 710. *Attention is directed especially to the rarity of pus in the back of the hand.* Over and over again one has seen the back of the hand incised when the pus is in the palm. The loose dorsal subcutaneous space readily becomes puffy from œdema (*Fig.* 711). If

the swollen back of the hand pits on pressure, it is safe to assume that pus is not present there. If the back of the hand is not only swollen but also indurated, it is probable that an incision into that area is indicated.

The **Hypothenar Space,** unlike the thenar space, is strictly localized. It does not communicate with any other space or tendon-sheath, and it is of comparatively small surgical importance.

The **Pulp of the Finger : The Terminal Fascial Compartment.**— The pulps of the fingers and thumbs are subjected to more pricks, and therefore infections, than any other part of the body. Nature has provided in this situation an effective, closed fascial compartment. This compartment extends from the tip of the digit to the level of the epiphysial line of the terminal phalanx—that is, a quarter of an
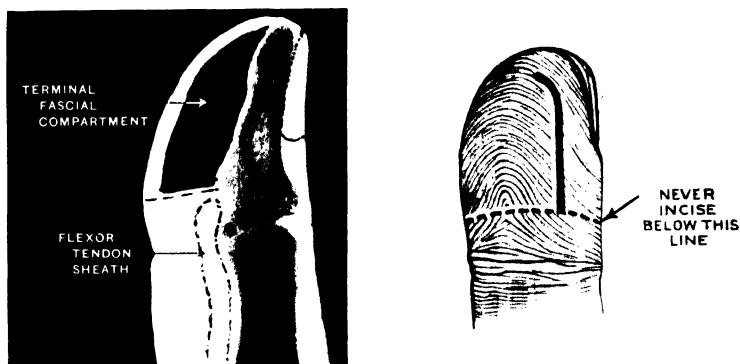
Fig. 712. The terminal fascial compartment in the pulp of a finger or thumb.

inch distal to the last interphalangeal crease (*Fig.* 712). Want of knowledge of the limitations of this compartment is serious, and may prove disastrous.

A man of 35 ran a file into the tip of his index finger, and suppuration followed. He attended a Casualty Department as an out-patient for two days, and then the finger was incised on the palmar aspect of the pad, the incision passing just proximal to the terminal interphalangeal crease. In other words, the incision encroached upon the territory of the tendon-sheath. Forty-eight hours later suppurative tenosynovitis ensued, which was not recognized for three days. Eventually amputation at the shoulder-joint failed to stay the onslaught of the septic process.

In infections limited to the pulp, to allow the incision to extend in a proximal direction any farther than half an inch from the terminal flexor crease is to break a surgical commandment by permitting the knife to enter hallowed ground.

Management and Treatment of Pulp Infections.— If tenderness is most marked over the pulp of the finger, it is permissible to wait for localization of pus to the aforementioned compartment, but do not wait for fluctuation. Give hot saline baths and fomentations. When the pulp feels indurated is the time to open.

Place a tourniquet in the shape of a rubber catheter around the base of the finger. A deep hockey-stick shaped incision (*Fig.* 713) is made into the pulp. No drainage material is used. Fomentations are applied for forty-eight hours, then paraffin dressings are substituted. The wound is irrigated daily with eusol squirted in by an aspirating syringe.
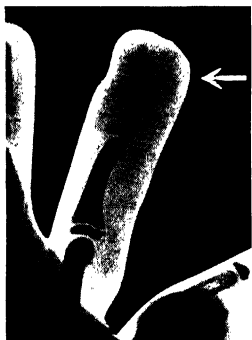
Fig. 714.—Radiograph showing necrosis of the terminal phalanx.

In late cases, as soon as the incision is made the diaphysis of the terminal phalanx literally falls out of a pocket of pus. In earlier cases the onset of osteomyelitis may be prevented, but this is a distinctly rare event. Usually some days or weeks later the diaphysis is picked out of the wound as a sequestrum. After sequestrectomy the wound heals within a week. It leaves a shortened phalanx with rather an ugly curved nail, but with full functional activity of the digit. In young children regeneration of the diaphysis sometimes occurs. In the interval between the incision and the healing of the wound or the removal of a loose sequestrum a weekly X-ray (*Fig.* 714) is desirable.

The Thenar Space.— Infections of the thenar fascial space produce much swelling. There is ballooning of the thenar eminence (*Fig.* 715). The thumb metacarpal becomes pushed away from the rest of the hand. Flexion of the distal phalanx may be considerable in this condition, but it lacks resistance to extension, which is so well defined in suppurative tenosynovitis of the flexor longus pollicis.

Boundaries of the Thenar Space.—

On the palmar aspect—the palmar fascia, which in this situation is thin and elastic.

Fig. 715.   ma of the thenar space,   ning of the thenar eminc

On the dorsal surface—the adductor transversus pollicis.

On the ulnar side—a septum of strong fascia attached to the middle metacarpal bone. This septum separates the thenar from the middle palmar space (*Fig. 716*).

Source of Infection.—The thenar space may become infected directly from a wound, but much more frequently it is involved by the bursting of the tendon-sheath of the index finger. Exceptionally it is involved in the same way from the flexor tendon-sheath of
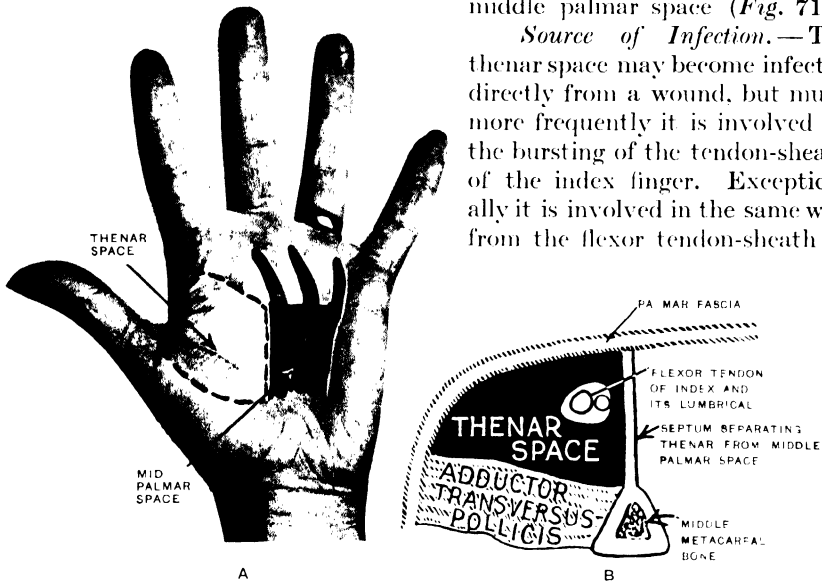
Fig. 716. A, The relative positions of the thenar and middle palmar fascial spaces. Note the three diverticula from the middle palmar space. B, Diagram of a transverse section through the thenar space.

the middle finger, and still more rarely from the flexor longus pollicis tendon-sheath.

Drainage of an Abscess of the Thenar Space.—Operation is imperative, the danger of delay is great. The results of opening a non-infected space are minimal.

The incision is made in the *dorsum*, and is shown in *Fig. 717*.

Fig. 717. Incision for draining the thenar space.

Cut down on the radial side of the metacarpal bone of the index finger. Take a hæmostat, introduce it into the incision, pass its nose across the palmar aspect of the bone, when the thenar space will be entered.

Do not thrust the hæmostat farther than the radial side of the middle metacarpal, or the middle palmar space will be endangered. This technique gives perfect drainage, and no tube or other drainage material is necessary.

It is essential of course to treat a suppurative tenosynovitis of the index finger, if such is present, at the same time (see p. 659).

The Middle Palmar Space.—Infections of the middle palmar space give rise to those enormous hands which may be likened to a whale's flapper. Obliteration of the concavity of the palm, with slight bulging thereof, is almost pathognomonic of the condition. The convexity of the palm is never great, because the resistance of the palmar fascia is so strong. Œdema may obliterate concavity, but it never produces convexity. There is no point of maximal tenderness in middle palmar space infections.

Boundaries of the Middle Palmar Space.—

On the dorsal aspect—fibrous tissue separating it from interosseous muscles.

On the palmar aspect—fascia separating it from the flexor tendons of the fingers with their lumbricals.

On the radial aspect—that fascial septum attached to the middle metacarpal which separates it from the thenar space.

The middle palmar space has three diverticula, which are the lumbrical canals of the middle, ring, and little fingers (see *Fig.* 716, A). *It is overlapped on the ulnar side by the ulnar bursa*, and therefore must never be incised directly from the palm, otherwise the ulnar bursa will become infected, a very grave matter.

Sources of Infection.— The middle palmar space may become infected from rupture of the tendon-sheath of the middle, ring, or little finger. It can also be infected directly by penetrating wounds of the palm, or from osteomyelitis of the middle and ring metacarpal bones. Very rarely infection of this space occurs as an extension from the thenar space by a bursting of the septum which divides them.

Fig. 718.—Incision for draining the middle palmar space. On no account drain the space directly through the palm.

Drainage.—Direct attack being forbidden absolutely for reasons given above, efficient drainage of the middle palmar space may be secured via a lumbrical canal. This is effected by opening up the web between the ring and middle fingers or the ring and little fingers. If a choice exists, the former is chosen (*Fig.* 718). The fingers are spread. The incision begins on the dorsum, and passes over the web on to the palm, but never beyond the distal flexion crease. The incision is deepened. Pressure is exerted over the middle palmar space. If pus wells up, a grooved director is inserted along the lumbrical canal. The incision is extended until the web is split completely almost to the distal flexion crease. A closed hæmostat is now inserted under the flexor tendon and its jaws are opened widely. No drainage material is necessary.

Usually an abscess of the middle palmar space is secondary to suppurative tenosynovitis of the middle or ring finger, which of course will require appropriate attention (*see* pp. 659, 662).

Treatment of Combined Middle Palmar and Thenar Space Involvement.—The middle palmar space is drained by the method just indicated. The forceps are passed under the flexor tendons and made to pierce the fascial septum attached to the middle metacarpal bone. The beak of the hæmostat passes on superficial to the adductor transversus, and is made to appear in the dorsum between the metacarpals of the thumb and index finger. A counter-incision is made here, and a narrow piece of corrugated rubber is drawn through so as to project through each incision. The drain is removed at the end of twenty-four hours.

The Dorsal Sub-aponeurotic Space. Once more attention is directed to the rarity of suppuration on the dorsum of the hand. The great œdema of the dorsum in palmar infections is due to the loose connective tissue on the back of the hand, which is rich in lymphatics. Pitting on pressure is a sign of œdema. If this gives place to induration, pus is present.

Drainage. Dorsal incisions are made in the inter-metacarpal spaces. Usually two suffice (*Fig.* 719).

Treatment of Combined Infection of the Middle Palmar and Dorsal Sub-aponeurotic Space.—This combined infection is a sequel to an infected compound fracture of the metacarpal bone, or to osteomyelitis thereof. It is drained most efficiently by a through-and-through incision from the palm to the dorsum. The point chosen for the incision lies on the middle palmar flexion crease, between the ring and middle fingers, thus avoiding the ulnar bursa and the thenar space. The palmar fascia is incised, and hæmostats are driven through the interval between the ring and middle metacarpal bones until they

Fig. 719.—Pus in the back of the hand is rare. It gives rise to an indurated swelling. The figure shows a case of infection of the dorsal sub-aponeurotic space, and the incisions employed for draining this area.

LUMBRICALS

ULNAR BURSA

RADIAL BURSA

ANNULAR LIGAMENT
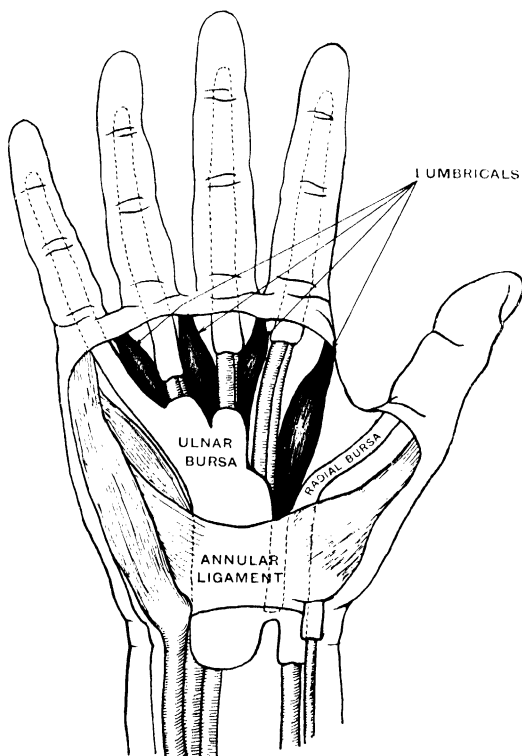
Fig. 720.—The lumbrical muscles

protrude on the dorsum, where the skin is incised over the protruding points. A narrow piece of corrugated rubber is drawn right through the thickness of the hand. The drain is removed at the end of twenty-four hours.

The Lumbrical Spaces.—The lumbrical muscles, or rather the canals in which they lie, play a large part in serious infections of the hand. They act as conducting channels for pus to travel from fingers to palm. It is advisable to be able to picture them clearly (*Fig.* 720). They arise from the flexor profundus digitorum tendons, the outer two by one head, the inner two by two heads. Their tendons pass around the *radial* side of the corresponding digit to reach the expansion of the extensor communis digitorum, into which they are inserted. The lumbrical canals often convey pus to the dorsal part of the web between two fingers.

Drainage.—The lumbrical spaces are exposed and drained by splitting the interdigital web.

PARONYCHIA

Paronychia is not a source of grave infection. The most serious complication is necrosis of the terminal phalanx, which only occurs in about 7 per cent of cases (Molesworth). Pus is present under the nail in 63 per cent of cases. The correct treatment is indisputable. It is early operation.

Elevate the hand for three minutes and apply a tourniquet in the form of a rubber catheter around the base of the finger. Make two lateral incisions as shown in *Fig.* 722, *a* ; in very early cases a unilateral incision suffices (*Fig.* 721), but it is wise to err on the side of radicalism. Avoid cutting the nail-bed by keeping the incisions well lateral ; if the nail-bed is cut, the new nail will grow up permanently split. Dissect down the flap.

Fig. 721.—Incision for very early unilateral paronychia without subungual suppuration.

1. **There is no Pus Under the Nail.**—In this case the operation just described suffices. A wisp of gauze soaked in liquid paraffin is inserted under the flap (*Fig.* 722, *b*). Hot, moist dressings of magnesium sulphate are applied *to the whole finger* for forty-eight hours. After that time local liquid paraffin dressings are alone employed.

2. **There is Pus under the Nail.**—After the flap (*Fig.* 722, *a*) has been turned down, insert one blade of a pair of scissors on the flat under the base of the nail and remove the portion of nail B (*Fig.* 722, *c*). It is unnecessary and harmful to remove the portion of nail A unless it

is detached. The portion A will exercise a protective action until the new nail grows up and forces it away—a process which takes about two months.
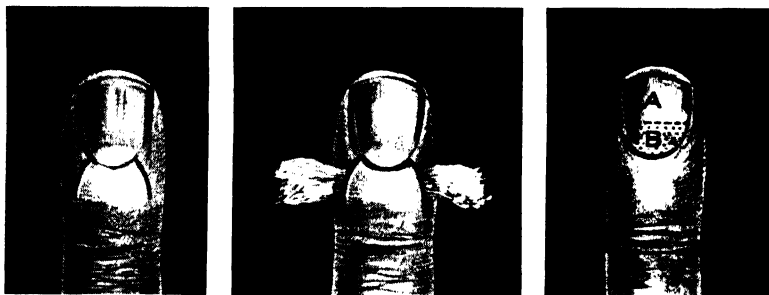
Fig. 722.— Incisions for the treatment of paronychia. *a.* Paronychia, incisions for turning back the flap. *b.* A wisp of gauze soaked in paraffin is used to maintain elevation of the flap. *c.* When there is pus under the nail the portion B is removed and the portion A is retained.

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CHAPTER XLI

BURNS

General Treatment in Severe Burns.—If the patient is suffering from shock, first treat the shock. Prescribe a suitable dose of morphia, or, in the case of a small child, nepenthe. The foot of the bed is raised and warmth applied. Salines are administered as necessary.

Treatment of the Toxæmia of Burns.—Continuous intravenous saline, by diluting the toxin circulating in the blood, is often of considerable help. Hyperpyrexia must receive immediate attention by cold sponging to the skin which is not burnt. Alkalis by mouth are given to mitigate acidosis. In the most severe types exsanguination-transfusion offers some hope.

Exsanguination-transfusion.—The toxin is in the circulating blood, and to save the patient's life its concentration must be reduced. This can be effected by bleeding the patient and then transfusing him with matched blood. In an infant 120 c.c. of blood are removed and 150 c.c. given. In a child of three, 250 c.c. of blood are removed and 300 c.c. given. In an adult half to three-quarters of a pint of blood is removed and one pint given.

Local Treatment.—The treatment of burns by tannic acid was introduced in 1925 by E. C. Davidson of the Henry Ford Hospital, Detroit, U.S.A. His work has revolutionized this branch of surgery. Tannic acid forms a leathery coagulum (*Fig.* 723) protecting the area denuded of skin and the exposed nerve-endings, thereby preventing much suffering. More than this, tannic acid fixes proteins and their metabolites, thereby locking up in the coagulum toxins which would otherwise be absorbed. The dreaded toxæmia of burns is prevented, and consequently more patients recover than formerly. The tannic acid method can be commenced as late as seventy-two hours after the accident, whether other methods have been used or not. After this time the danger of toxæmia, which is most in evidence between the sixth and the twenty-fourth hours, has to a great extent passed.

Special Warning.—No water must come in contact with the coagulum, otherwise the toxins will be liberated. I know of a dramatic example of this danger. A man had a large burn of the abdominal wall and thigh treated by tannic acid. On the eighth day slight sepsis was observed about the coagulum, but the patient was comfortable and gave rise to no anxiety. Fomentations were ordered

by someone unfamiliar with the treatment, and in forty-eight hours the patient was dead.

Fig. 723. –Burns treated by tannic acid. **A,** Condition on the sixth day—the coagulum has turned jet black ; **B,** The same patient after the tannic acid coating had peeled off.

Cleansing the Burnt Area. –Infinitely the most important part of the treatment is cleansing and sterilization of the burnt area. If the tissues involved are rendered surgically clean subsequent sepsis is improbable, and scarring will be reduced to a minimum. In order to carry out effective cleansing *a general anæsthetic is usually necessary,* gas and oxygen being by far the best in this instance.

Preparation of the Solution.—The 40 per cent solution of tannic acid in 1–1000 acriflavine appears to be the best. It is prepared by dissolving two ounces of tannic acid powder (approximately a tea-cupful) in five ounces of 1–1000 acriflavine in water.

Technique of the Tannic Acid Treatment.—

1. Open the blisters and cut away loose epithelium with scissors.
2. Scrub the burnt area and all the unburnt surrounding skin

with a boiled loofah soaked in ether soap. Ablution must be most thorough, leaving a clean, raw surface.

3. Apply surgical spirit to the whole area.

4. Dry with ether applied on a swab.

5. Paint with the 40 per cent tannic acid solution, applied with a swab or a brush.

6. Dry, preferably with an electric hair drier (*Fig.* 724) ; failing this with an ordinary fan or a folded towel.

7. The burnt area becomes a golden brown. This is the signal that the anaesthetic can be discontinued.

8. As the patient is coming round from the anaesthetic three or four more applications of the 40 per cent solution are applied, the part being carefully dried between each.

By this time the area being well tanned, it is covered with a sterile towel and the patient returned to bed, where he is laid upon a sterile sheet and covered with a cradle. Electric bulbs are hung inside the cage to assist in keeping the coagulum dry. To avoid the area becoming moistened with sweat, the bedclothes should be reduced to a minimum. Anti-shock treatment is continued in necessary cases. The nurse should be instructed to prevent all soiling of the treated area and,

Fig. 724. An electrical hair drier aids greatly in drying the area quickly.

above all, to see that it is kept dry. The next day the areas are inspected, and the coagulum, which by now is thick and of a rich brown colour, is strengthened by a further application of the solution. The coagulum continues to darken in colour for two or three days until it becomes almost jet-black. As soon as the coagulum has hardened the application of dressings is no longer necessary.

In uncomplicated cases the process of healing proceeds apace under the protective covering. The covering should not be interfered with until it loosens, when it can be peeled off (*Fig.* 725). This takes a varying period according to the depth of the burn—usually a matter of twelve to fourteen days. After the covering has been removed the area is protected with gauze smeared with sterile vaseline and bandaged. Elastoplast plaster dressing is a good alternative. Skin-grafting is performed in necessary cases.

Modifications and Additions to Suit Particular Circumstances. —
In children the arms and legs must be fixed to the sides of the cot by
turns of bandages. Splints may be advisable (*Fig.* 726).

Fig. 725. —Treatment of burns by the tannic acid method. Desquamation of
the coagulum.

Burns of the Head and Face. —Evipan anaesthesia or ether anaes-
thesia administered by a Shipway's apparatus allows access to the
face.

The eyes must be protected with wads of wool soaked in saline
and the nostrils plugged with the same material.

Fig. 726.— Splints applied to fix the limbs in a case of burns in a child.
¡(*By kind permission of ' Surgery, Gynecology and Obstetrics.'*)

The face is then scrupulously cleansed and sterilized in exactly
the same manner as that described already and the 40 per cent solu-
tion of tannic acid is applied. The patient should be under the

surgeon's observation until he is round from the anæsthetic, when he is sent back to the ward with no dressings, but the head lying on a sterile towel.

Burns of the Buttocks and Perineum.—Especially in children, precaution must be taken to avoid the coagulum becoming wet with urine. As soon as the coagulum has set, paint the area with a thick coat of collodion or 'new skin', which renders it, to a great extent, waterproof. The bowels must be kept empty with enemata.

Supervention of Infection.—Mild infection characterized by the discharge of seropurulent fluid in a localized portion of the periphery of the burnt area, together with some reddening of the skin, need not occasion alarm, and expectant treatment should be continued.

Gross infection, where pus accumulates beneath the coagulum, must receive attention. With scissors a window is cut in the coagulum, and the pus allowed to drain away. In other cases it may be wise to remove the whole of the coagulum. Again it must be emphasized that a watery solution must not be used to soften the coagulum, because of the danger of releasing imprisoned toxins. It should be softened with vaseline, after which it can be removed readily. The underlying purulent wound may then be treated with eusol dressings.

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CHAPTER XLII

THE BLOOD

ANAPHYLAXIS (SERUM SHOCK).

Serum therapy is advised in many conditions in this work. Consequently it is necessary to draw the reader's attention to the curious and alarming phenomenon of anaphylaxis. Severe anaphylactic shock is comparatively rare ; it has been estimated that it only occurs in one case in 20,000, but experience would dictate that this estimate is too sanguine.

Prevention.—

1. Inquire whether the patient has had serum administered in any form previously, also whether he suffers from asthma or hay fever.

2. Inject a few minims of the serum subcutaneously, and wait half an hour to see if it produces a local urticaria.

3. If a large dose of serum is to be given intravenously inject half or three-quarters of the proposed dose intramuscularly three or four hours before, and note the result.

4. If serum is diluted with a large volume of saline, and the mixture given intravenously by the continuous method, symptoms of anaphylactic shock are improbable.

5. When giving serum intravenously always have at hand a syringe filled with 1/100 gr. of atropine and some adrenalin ready to inject immediately in case of sudden cyanosis or respiratory spasm.

6. Profuse perspiration, headache, and, occasionally, vomiting may occur during the introduction of serum intravenously. If any of these, or other untoward symptoms, are noticed, stop the intravenous injection at once. When the patient's condition has improved inject the serum intramuscularly : 100 c.c. of serum at blood heat can be given almost painlessly into each gluteal mass, but usually, from a therapeutic point of view, the intramuscular route is inferior to the intravenous.

7. After a successful intravenous administration a certain amount of shock is to be expected. The patient should be well wrapped up and provided with hot-water bottles.

Anaphylactic shock often comes on with dramatic suddenness. There is difficulty in breathing, followed, in the most acute forms, by asphyxia. In other cases there are premonitory headaches and the patient complains of loss of vision. Gastro-intestinal symptoms

are sometimes in evidence, and blood and mucus are passed per rectum. Distressing urticaria and swelling of the lips and other mucous membranes are usual. Oliguria and albuminuria complicate the case.

The immediate *treatment* is to clear the airway and perform artificial respiration if necessary. Oxygen and CO_2, if at hand, should be administered. Inject 10 min. of adrenalin and 1/100 gr. of atropine as soon as possible.

Serum rashes accompanied by arthralgia and pyrexia are comparatively frequent after a large dose of any serum. The exhibition of calcium and the injection of adrenalin is sometimes beneficial in serum shock.

SEPTICÆMIA (WITH SPECIAL REFERENCE TO STREPTOCOCCAL SEPTICÆMIA)

The main hope seems to lie in flooding the circulation with antitoxin as early as possible. Blood transfusion is also undoubtedly beneficial. In streptococcal cases commence by giving concentrated streptococcal (scarlet fever) anti-toxic serum (Burroughs Wellcome and Co.), 40 c.c. intramuscularly. If the patient tolerates this well a further 60 c.c. should be given intravenously, either diluted with the blood, in the course of a blood transfusion, or admixed with saline and glucose as a continuous intravenous saline. When the serum is diluted in saline and administered intravenously, a much larger dose can be given, and in addition the saline will be beneficial.

HÆMOPHILIA

The subjects are always males, and a familial history of transmission through the maternal side of the family can usually be obtained. Coagulation of blood fails to take place because of a fault in the prothrombin.

A. D., a boy of 9, cut his head. It was a deep cut extending through the epicranial aponeurosis. The wound was sutured during the afternoon in the casualty department. At 10 p.m. he was admitted with a large extravasation of blood into the danger area of the scalp. The dressing which had been applied was soaked in blood. A stitch was removed, and a large quantity of blood evacuated from beneath the epicranial aponeurosis. The wound was resutured, and pressure was applied by means of a chin-strap. Next morning his condition had improved, and the chin-strap was released in order to allow him to feed. The bleeding restarted, and continued all day, in spite of Wright's styptic, iron and alum, and other attempts to stanch the hæmorrhage. By this time he was profoundly anæmic and his general condition gave rise to considerable anxiety. Twenty c.c. of blood from another patient were given subcutaneously into the abdominal wall. The hæmorrhage soon ceased, and recovery was uneventful. The same patient was seen five years later with a hæmophilic arthritis of his knee.

J. G., a male, aged 5, was admitted with epistaxis of three days' duration. He had vomited large quantities of swallowed blood, and was *in extremis* from anæmia. There was a typical history of familial bleeding. Twenty c.c. of blood were collected from a patient who had just had appendicectomy performed. The posterior nares were plugged with gauze soaked in adrenalin and a little of this foreign blood. The remaining 15 c.c. were injected into the child's abdominal wall. Recovery.

It will thus be seen that the essential feature in hæmophilia is to supply even a small quantity of foreign blood containing prothrombin. As a rule it is quite sufficient to inject this blood subcutaneously, which saves the delay of grouping the patient for a transfusion. Blood transfusion can be performed later in cases in which it is necessary.

Recent research indicates that bleeding in hæmophilies can be arrested by the local application of the venom of Russell's viper. The venom is kept in the dry state to prevent decomposition, and is applied in 1-10,000 dilution. In this strength the venom still possesses powerful coagulant properties, but is harmless.

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CHAPTER XLIII

ACUTE SPECIFIC INFECTIONS

TETANUS

" Not a moment should be lost in administering antitoxin " (War Office Committee on Tetanus).

A butcher of Lichfield, aged 26, whilst driving an unruly calf, got his thumb scored by the rope, and soon afterwards was thrown down in the mud. On his way home he had the thumb painted with iodine and bandaged. Nine days later his jaw became stiff. On the tenth day, whilst eating his tea, the jaw became locked. At 7 p.m. his neck became stiff, but there was no pain. During that night spasms developed. In the early morning he was sent in an ambulance to Birmingham.

On admission there was trismus, head retraction, and opisthotonos coming on in spasms. His temperature was 99 and pulse 100. As soon as he was in bed morphia ¼ gr. was administered ; chloretone gr. 20, with sufficient olive oil to dissolve it, was ordered to be given slowly into the rectum : 20,000 units of antitetanic serum were given intramuscularly. The same evening he was anæsthetized with chloroform. Lumbar puncture was performed, and 13 c.c. of cerebrospinal fluid allowed to escape. Then 10 c.c. of Burroughs & Wellcome's concentrated antitoxin (= 10,000 units) was injected slowly into the theca. This was followed up by an intramuscular injection of 10,000 units of ordinary antitetanic serum. On the next and two subsequent days the same procedure was adopted. On the fifth day there was a very slight improvement and the intrathecal dose was reduced by one-half. On the sixth day there was considerable improvement, and from the sixth to the twelfth days only 2000 units of ordinary serum were injected subcutaneously. On the fourteenth day he could chew his food. After this convalescence was uninterrupted.

The widespread adoption of a prophylactic dose of antitetanic serum has reduced the incidence of this preventable disease, but there are still far too many cases of tetanus. The public need more education on the importance of seeking immediate prophylactic treatment in wounds and abrasions contaminated by road and garden dirt.

SERUM TREATMENT

Prophylactic Dose.—All that is necessary in an average case is 500 units of serum. In grossly contaminated and extensive wounds 1000 or even 1500 units may be given.

Curative Dose.—Once symptoms of tetanus have developed, massive doses of antitetanic serum offer the best, and perhaps the only, hope of staying the onslaught of this dread disease. As much as 150,000 units may be given on the first day of treatment.

Methods of Administration.—The serum may be given intrathecally, intramuscularly, intravenously, or subcutaneously. The advantages and disadvantages of these various routes will now be discussed, together with the appropriate technical details.

The Intrathecal Route.—Intrathecal administration ensures that the antitoxin comes in contact with the nervous tissue involved in the shortest space of time. This route is hailed by authorities on the subject as the best. Because only a relatively small bulk of serum can be injected into the theca it is necessary to use the concentrated form. High-potency, or concentrated, antitetanic serum is issued by Messrs. Burroughs Wellcome & Co in 10-c.c. phials. Each phial is equal to 10,000 units. It is warmed in a water-bath at 100° F. The patient is anaesthetized with evipan or chloroform, lumbar puncture is performed, and 12 or 13 c.c. of cerebrospinal fluid is allowed to escape. The 10 c.c. of warmed serum is injected very slowly. After the puncture has been sealed the patient is rolled on his back and the foot of the bed is raised to aid the gravitation of the serum. After three hours the bed is restored to its normal level.

The initial intrathecal dose of serum often gives rise to a certain degree of aseptic meningitis. The temperature rises and the patient may appear to be worse, there being increased rigidity of the neck and limbs. When the second lumbar puncture is made the cerebrospinal fluid will be found to be slightly turbid. If the disease is yielding to treatment, these symptoms pass off in two or three days. A daily intrathecal injection is advisable until some definite improvement, however slight, sets in, when this route can be abandoned for one of the others. As a general rule two intrathecal injections suffice. B. B. Yodh, who has had a large experience of cases of tetanus in Bombay, favours the injection of antitetanic serum by cisternal puncture, especially in advanced cases. By this means the antitoxin is brought into more direct contact with the vital centres.

The Intramuscular Route.—In the early stages of treatment the intramuscular route is employed as a subsidiary one. The usual dose for an adult is 10,000 to 20,000 units of serum. The warmed serum is divided into two equal parts and injected into the upper and outer part of each gluteal mass. The vastus externus is also a good muscle for receiving the injection.

The Intravenous Route.—The intravenous route for antitetanic serum is decidedly unpopular because it is often followed by anaphylactic phenomena. If the precaution of giving warm serum after a preliminary trial of a few drops of serum diluted in saline were carefully taken, many of the objections to the intravenous route would be overruled. It is obvious that the intravenous route is an excellent

one for flooding the circulation with antitetanic serum ; but the combined intrathecal and intramuscular method has proved so satisfactory that most observers are prepared to stand by it. Occasionally cases will be encountered where it may be thought desirable to use the intravenous route : 30,000 units of warmed serum is a suitable initial intravenous dose for an adult. In a case of tetanus in a lad of 12 J. H. Grove-White injected 700 units intravenously and 8000 units of concentrated serum intrathecally, and repeated the dose on two subsequent days. Recovery followed.

The Subcutaneous Route.—Absorption is too slow for this method to be recommended except when improvement has started already.

GENERAL TREATMENT

The patient must be kept in a quiet, darkened room. Absolute quiet is essential. The slightest noise may provoke a painful spasm. Thoroughly skilful nursing is of the utmost importance. The temperature must be taken in the axilla or groin, but if the spasms are occurring frequently, even this disturbance must be avoided. Dressing of the wound must be done quickly and deftly. Laxatives given by the mouth are less disturbing than enemata.

Feeding the patient is the most important detail. Concentrated liquid nourishment such as milk, eggs, Allenburys' diet, soups, and fruit juices can be taken by mouth even when trismus is pronounced. Usually the patient can suck up the liquid nourishment through a straw. In extreme cases a small rubber catheter can be passed between the teeth and the cheek and the nourishment introduced either through the gap of a missing tooth or behind the third molar. Nasal feeding is objectionable and unnecessary. I wish strongly to disparage the introduction of liquid food while the patient is anæsthetized. I have seen a fatal case of asphyxia from this cause.

Excision of the wound is usually a better method than treating it by antiseptics. Dressings of hydrogen peroxide and eusol are rational as the organisms are unlikely to multiply in the presence of oxygen. The advisability of excising healed wounds is questionable ; it is possible that the tetanus bacillus in such wounds is no longer producing toxin. When it is impossible or inadvisable to excise the wound several authorities advocate injecting phenol 2 per cent in and about the area.

Control of the Spasm.—Morphia is the stand-by. For the control of the painful spasms 20 gr. of chloretone in olive oil given by rectum is useful. When the spasms are frequent and severe, chloroform or evipan anæsthesia may be resorted to. A most valuable method of reducing the spasms in severe cases is the intravenous injection of a 3 per cent solution of magnesium sulphate—its action is dramatic.

E. S. 44

The injection should be given very slowly, i.e., not more than 5 c.c. per minute, until relaxation is obtained. In a severe case the spasms often return in about 4 hours, when a further injection is needed.

ANTHRAX

CUTANEOUS anthrax may occur in any part of the body, but the face is the favourite site (*Fig.* 727).

The incubation period is from three to four hours to three to four days. The first sign is the formation of a papule. Within twenty-four to thirty-six hours small vesicles form on or about the now enlarged papule, and the surrounding skin becomes red and œdematous. About this time there is usually some fever, the temperature registering 100° to 101° F.

Fig. 727. Cutaneous anthrax, successfully treated by anti-anthrax serum. (*Dr. A. E. Hodgson's case.*)
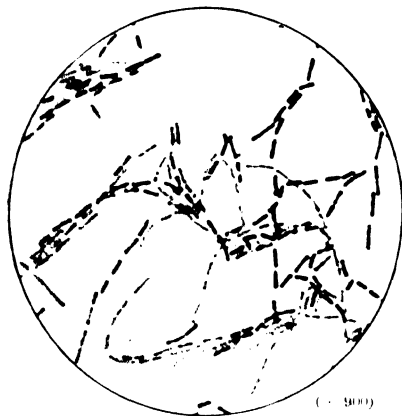
Fig. 728. Anthrax bacillus, culture. (*By kind permission Park and Williams' 'Patho Micro-organisms.' Philadelphia : de Febiger.*)

In the past the lesion was excised, leaving a hideous scar. I have seen a supposed malignant pustule of the cheek cut out, leaving a hole 1½ in. in diameter. In this particular case the pathological report was returned ' *Staphylococcus aureus* '. A disaster such as this emphasizes the necessity of a bacteriological confirmation of the diagnosis. In a case of suspected anthrax the vesicle should be pricked and a little of the serum examined by making a film and staining it by Gram's method. If the large anthrax bacillus is seen (*Fig.* 728), the diagnosis is absolute. Sometimes the bacillus is not found, and animal inoculations have to be made to prove its presence. If the angry pustule or the œdema makes the diagnosis tolerably certain, the case should be treated as anthrax. *It is quite unnecessary to excise the lesion.*

Treatment.— So successful has been the treatment of anthrax by salvarsan that it puts in the shade treatment by serum and other methods. An intravenous injection of 0·6 grm. daily, or on alternative days, according to the severity of the symptoms, is the procedure recommended. Pijper states that at the Pretoria Hospital, South Africa, all cases entering with anthrax were treated exclusively with salvarsan. There were no deaths in the records of over forty consecutive cases.

ERYSIPELAS

Erysipelas is contagious, therefore the patient should be isolated. But as a matter of fact it is very rare for erysipelas to be conveyed from one patient to another. Panton and Adams showed this point clearly. At St. Thomas's Hospital cases of erysipelas were kept with the other septic cases between 1895 and 1905. After 1905 they were isolated, but the incidence of erysipelas developing in the septic ward was not diminished.

Local Treatment.—The inflamed area is washed gently with ether soap, and 50 per cent ichthyol in lanolin is applied in the form of a paint, after which a thin layer of gauze is applied. In the case of a child 25 per cent of ichthyol is sufficient. Short exposures of the affected area to ultra-violet light appear to be of benefit.

General Treatment. Antistreptococcal serum may be given, and perchloride of iron, 10 to 30 min., is usually prescribed. The administration of alcohol is said to be of benefit. Hyperpyrexia must be treated by cold sponging.

After the rash has died down subcutaneous abscesses may form. I have been called to treat many such cases, and in some of these extensive collections of thin pus were found.

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CHAPTER XLIV

CELLULITIS, ABSCESS, CARBUNCLE, ETC.

SUBCUTANEOUS CELLULITIS

IT should be noted that these remarks apply to *subcutaneous* cellulitis. Cellulitis of a fascial space requires immediate surgical intervention, as has been pointed out in the sections dealing with Ludwig's angina (p. 541), extravasation of urine (p. 378), and infection of the fascial spaces of the hand (p. 670)

Subcutaneous cellulitis may be a dangerous diagnosis, especially in children, in whom an underlying bone condition must always be excluded. The following account refers particularly to subcutaneous cellulitis of a limb, and more especially to cellulitis following a small abrasion, or where there is no demonstrable lesion.

Avoid making multiple incisions into the inflamed area—a procedure which has too long been a standard method of treatment. Usually no pus is found. The incisions reveal œdema of the subcutaneous tissue, and a little watery fluid exudes. These untimely incisions often incite the inflammatory process to greater activity.

When there are constitutional symptoms order the patient to bed. Apply large hot dressings soaked in a saturated solution of magnesium sulphate. A really ample dressing which will more than cover the whole area is required. Gamgee tissue soaked in the solution and covered by jaconet is what we usually employ. In severe cases antistreptococcal serum is given in 10-c.c. doses daily. The result of this simple treatment is remarkably successful. Occasionally the whole of the cellulitis resolves. More frequently the suppuration becomes confined to a localized area, which needs incision. In cases without an obvious focus, when the cellulitis has subsided one sometimes finds that the suppurative process is connected with a prepatellar bursa or an olecranon bursa. Rarely, a large area of subcutaneous tissue becomes filled with pus. It is then necessary to make more than one incision, and to design these incisions to lie at the most dependent point so as to favour drainage. *When there are no constitutional symptoms* the affected part can be covered with an elastoplast bandage. In the case of a leg or arm the elastoplast is made to encircle the limb, which is placed in a splint or a sling. The relief of pain is almost immediate. The patient is told to report in four days, or before if he does not feel well in himself. The limb is then palpated through the elastoplast, and if no pain is elicited and no

fluctuation felt, he is asked to report a week later, when the bandage is removed.   Only if an abscess results is incision required, and quite often no such abscess forms (John Robb).

PERIPHERAL THROMBOSIS AND THROMBOPHLEBITIS

Of the Lower Limb. —Thrombophlebitis of the superficial veins of the leg is a common complication of varicose veins.   The limb hould be elevated on an inclined plane and kept strictly at rest.   Magnesium sulphate fomentations are applied.   Usually the condition resolves without incident, although it often takes more than a fortnight to subside. Naturally one is fearful, especially when the condition has advanced above the knee, that pyæmia or pulmonary embolus will occur.   In practice it is found that these are both rare complications.   In cases which are spreading I have reflected several times on the advisability of tying the saphenous vein, but have never done so, and have not regretted the omission.   In one example occurring in a comparatively young man the patient had already 'shot' an infected embolus into his right lung, and exhibited general symptoms of a grave infection. He was treated by a blood transfusion, followed by daily intravenous injections of mercurochrome, and recovered.

Of the Upper Limb. —Thrombosis of the axillary vein is not very common, and appears to occur spontaneously in healthy individuals. The swollen and engorged arm should be raised and kept at rest.   In the two cases which I have seen this inactivity was entirely successful.

LYMPHANGITIS

Red lines are seen coursing up the limb.   Lymphangitis is a dangerous condition and the patient should be ordered to bed.   Occasionally lymphangitis passes on to septicæmia.   The temperature chart here shown (*Fig.* 729) illustrates a case of galloping septicæmia.   The patient was admitted with a scratch on the

Fig. 729. Case of lymphangitis secondary to an infected scratch. Galloping septicæmia resulted.

with lymphangitis.   In two days she was dead.   Fortunately such examples are uncommon.   An evident primary lesion must receive proper attention —often it is only a small scratch or abrasion.   The whole limb is wrapped in wool and bandaged.   Antistreptococcal   serum   is   advised,   because
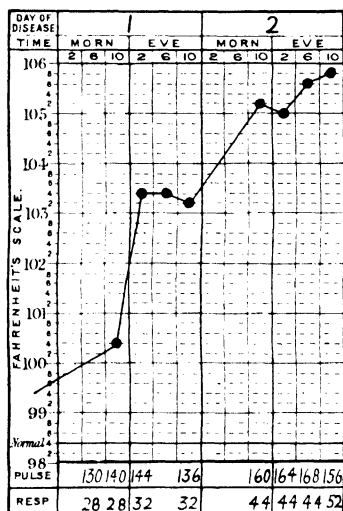
lymphangitis is always due to a streptococcus. Intravenous mercuro-
chrome is useful when the general symptoms are marked. A watch
must be kept on the lymphatic glands of the axilla or groin; if
they are enlarged and tender, fomentations are ordered.

This is a convenient place to discuss the treatment of abscess
of the groin and axilla.

Abscess of the Groin.—A frank abscess is opened by a vertical
incision.

Dissection of the inguinal glands may be advisable while the
inflammation is still limited to the gland. Many times I have seen
this carried out successfully in cases of inflamed inguinal glands
secondary to a soft sore. After the glands have been removed and
every bleeding point ligatured the interior is smeared lightly with
B.I.P.P. The wound is closed without drainage.

The difficulties in diagnosis of a suppurating gland of Cloquet have
been referred to already in the section on femoral hernia (*see* p. 277).

Axillary Abscess.—Abscesses of the axilla must be opened
promptly, for the pus tends to extend along the path of the nerve-
trunks into the neck. The site of the incision will depend upon the
situation of the pus. *In acute abscesses
pus usually lies under the pectoralis
major.*

*Fig. 730. Opening a deep-seated
axillary abscess.*

Fully abduct the arm. Make an
incision quite two inches long just
below the fold of the pectoralis major
(*Fig.* 730).

*Hilton's Directions for Opening a
Deep Abscess in the Axilla.*— Cut
through the skin, cellular tissue, and
fascia of the axilla about half an inch
behind the axillary edge of the great
pectoral muscle. At that part we
meet with no large blood-vessel. Then
push a grooved director upwards into
the swelling in the axilla; if you
watch the groove in the director, a
little stream of pus will show itself.
Take a blunt pair of forceps and run
the closed blades along the groove in the director into the swelling.
Now open the handles and so tear open the abscess.

In late cases, when the whole axilla is merely a bag of pus, an
incision into the lower part of the middle of the space will be found
convenient.

Occasionally it is wise to dissect out suppurating axillary glands.

W. W., aged 30, had an infected scratch on the back of the hand. For more than a week the axillary glands had been enlarged and tender. His temperature was normal, but there was a large tender mass under cover of the pectoralis major. An ample incision was made just beneath and parallel to the muscle, through which five glands were readily dissected out. Two of these glands were larger than the remainder, and later these were found to be full of pus. A drainage-tube was passed through a special stab-wound in the middle of the axillary space. The original incision was closed completely and it healed uneventfully.

ACUTE ABSCESSES IN GENERAL

Methods of dealing with special abscesses, e.g., ischiorectal, peri-urethral, mammary, etc., will be found in the appropriate sections. We here refer particularly to miscellaneous abscesses which are encountered commonly. In opening an abscess aseptic precautions must be as perfect as in a clean case. In deeply situated collections of pus an incision should be made large enough to admit the little finger. The deep fascia is generally perforated with sinus forceps or a hæmostat, but the little finger is used to explore and break down loculi if such exist (*Fig.* 731). A rubber drainage tube is often necessary. Do not wash out the abscess cavity; allow the pus to drain away through the tube. In superficial abscesses, after the pus has been evacuated, John Robb advises the application of elastoplast or viscopaste bandage, together with a splint, if necessary. If discharge oozes through it is washed away with soap and water, but the bandage is not removed for a week, and nothing is applied over the bandage which might hinder free evaporation; the freer the evaporation the less discharge. When the abscesses occur in

Fig. 731. The little finger is introduced into the abscess cavity and is used to explore and when necessary break down loculi.

soft tissues, such as the neck or the buttock, and a large non-collapsible cavity results, the abscess cavity is packed with gauze soaked in pure glycerin before the elastoplast is applied. It is necessary to remove the pack every five days. After drying the skin with surgical spirit it is again covered up with elastoplast, or, if the skin is pustular, with viscopaste bandage.

BOILS

A Boil in the Early Stage.—After trying all manner of treatments I am most satisfied with the following. Gently shave the surrounding area. Wash the boil with alcohol. Smear sparingly the surrounding skin with blue ointment, and wipe away all excess. Over the boil place a piece of elastoplast one inch in diameter. Hold it there until it is adherent firmly. Prescribe general treatment—Easton's syrup half a drachm t.d.s., and if possible general artificial sunlight. If exquisite pain is not experienced, leave the plaster alone for two or three days. When it is removed the boil will be discharging, and soon afterwards the core may be picked out. Collect some pus and send it to a pathologist for an autogenous vaccine, for boils are notoriously recurrent. If pain is a marked feature, the plaster must be removed and hot magnesium sulphate fomentations substituted. It is unnecessary and meddlesome to incise boils, and under no circumstances must they be squeezed, except to aid the expulsion of a separated core.

CARBUNCLE

The urine must be tested for sugar. If the patient has diabetes the services of a physician should be requested. Operative treatment of the carbuncle is contra-indicated :—

1. When the patient has diabetes.
2. In facial carbuncle (*see* p. 495).
3. When the carbuncle is spreading.

Conservative Treatment.—In any case it is best to commence with conservative treatment. Fomentations wrung out in a saturated solution of magnesium sulphate are applied. If pus is exuding a specimen is sent to the laboratory with a request for an autogenous vaccine. Many carbuncles do extremely well under this simple non-operative treatment, which may be combined with auto-injection of whole blood. I have been well pleased with this method.

Auto-injection of Whole Blood.— To be efficient, blood injection must be carried out according to Carp's technique, otherwise it leads to disappointment.

The area is prepared in the usual manner. The patient is anaes-thetized with gas and oxygen. At least 20 c.c. of blood are with-drawn from the median basilic, the blood being mixed with citrate solution. Commence the injection beyond the margin of induration of the carbuncle. The needle is pushed into the skin, and sub-cutaneous injection is begun under considerable pressure. Gradually the needle is pushed deeper and deeper until but little pressure is required to force the blood. At this point the needle has probably penetrated deep enough for the blood to extravasate through the

deep necrotic tissue. The needle is then withdrawn. The same
procedure is followed until the lesion has been circuminjected (*Fig.
732*), *a new sterile needle* washed through with citrate solution being
used for each injection. It is advisable to allow some blood to well
up through the centre of the carbuncle. The tissues about the
carbuncle are seen to swell up because of the injected blood. About
three to six punctures are necessary. The amount of blood injected
varies from 10 to 70 c.c., according to the size of the carbuncle.

is carbuncle was treated by the auto-injection of blood at the
45 c.c. of blood were injected. A scalpel was then taken
penings joined up. Within a week there was a clean, granu-
ch healed permanently.

Operative Treatment. Under gas and oxygen or evipan anæs-
thesia a large crucial incision is made well into the red, indurated
tissue at the periphery. The slough is removed from the centre by
wiping it firmly with a gauze swab. The four flaps resulting from
the incision are dissected up and their apices are removed, erring on
the side of liberality. Thorough scraping with a sharp spoon, some-
times recommended, is repugnant to my conception of living path-
ology, for between the slough and the healthy tissue there is a barrier
of active leucocytes. The centre of the cavity and the area under the
flaps is packed with gauze soaked in pure glycerin. Elastoplast strips
are then applied as an over-all dressing. The area need not be touched
for three or four days, when a similar dressing is applied. I have
found this treatment very effective in some cases ; in others the

patient finds magnesium sulphate dressings more comforting. When the sloughs have separated dressings of red lotion are applied; granulation usually proceeds apace under this treatment. Occasionally skin grafting is necessary.

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CHAPTER XLV

THE NOSE, NASO-PHARYNX, AND NASAL SINUSES

By ERIC WATSON-WILLIAMS, CH.M.

Fracture of the Nasal Bones.—*See* p. 515.

Severe Epistaxis.—*See* p. 516.

INJURIES TO SOFT PARTS

THESE should be dealt with by careful suture after disinfection with liquor iodi; conserve any skin that is not hopelessly damaged or contaminated. Where a part has been completely severed, wash it in sterile saline and stitch it in place; healing may be secured even after two or three hours.

J. N. Roy's Case.

A boy of 7 put his head through the head-lamp of a car, and in withdrawing it cut off the tip of his nose on the broken glass. The bleeding was controlled while the father was sent back to find the tip of the nose; this was washed in tepid saline, and placed in saline at blood heat. Three hours after the accident the tip was sutured into place with silk, threaded on a conjunctival needle. A light dressing was placed in the nostrils, and exteriorly, and a metal splint was fitted over the tip. The nostril dressings were changed on the second day, and thereafter daily; the external dressing was changed on the fifth day. A complete cure resulted.

FOREIGN BODIES IN THE NOSE AND NASOPHARYNX

The patient is usually a child or mentally abnormal; even a quite young baby may get something up the nose. The entry is sometimes through the cheek, as in such an accident as falling on a stick. The common sites of impaction are between the septum, the middle turbinal, and (*a*) the lateral wall of the nose in front of the latter, or (*b*) the inferior turbinal. A foreign body entering the mouth may be projected up into the nasopharynx, especially if it has a point or hook; in this situation it may be 'felt' as if near the cornu of the hyoid, so that the surgeon may be misled (*Fig.* 733). Once impacted there is little tendency to spontaneous ejection. Unless very far back or high up, the recently introduced foreign body is readily seen on removing blood and clot. Sometimes it is necessary to use a spray of dilute adrenalin (1 10,000), or to pack the nose with a strip of gauze wet with the adrenalin, in order to arrest bleeding and obtain a view. In doing this be careful not to push the foreign body farther

up. A skiagram may help in a difficult case. A foreign body that
has been long in the nose becomes encrusted with a calcareous deposit ;
a purulent nasal discharge is usual.

Treatment.—

Anæsthesia.—For adults and older children local anæsthesia
may be obtained by using gauze moistened with 5 per cent cocaine
solution containing the proportion of adrenalin mentioned above.
If the patient is sufficiently docile to keep quite still, or small enough
to be firmly held, no anæsthetic is necessary for the removal of such
bodies as peas, buttons, etc., which are easily accessible. Children
are often frightened by being
held, and if the patient is strug-
gling it is difficult to secure real
immobility. A *general anæs-
thetic* is indicated when : (1) The
patient is not docile or readily
controlled ; (2) The foreign body
is far back, high up, in the naso-
pharynx, or firmly impacted ;
(3) The foreign body is fixed by
points or hooks, especially if
these are pointing toward the
nostril.

Operation.—The nostril is
dilated and steadied by means
of a nasal speculum ; if one is
not available, a piece of wire
or the once common hair-pin
should be bent into the required
shape. Illumination from a fore-
head lamp or mirror is neces-
sary. The most generally useful
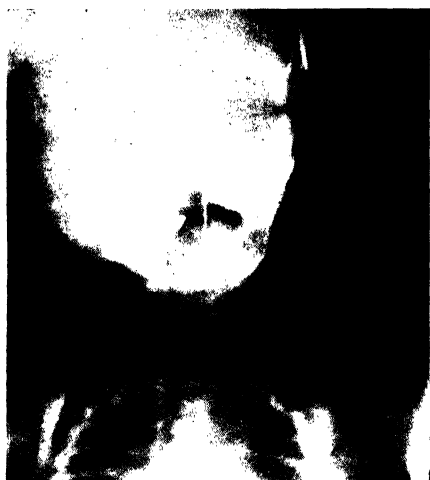
*Fig. 733. Skiagram of safety-pin in the
nasopharynx. Patient aged 3 weeks. (By kind
permission of the Editor of the 'Bristol Medico-
Chirurgical Journal.')*

instrument is a forceps with scoop ends, such as the smallest Luc's
forceps (*see Fig.* 741, 23, p. 707) or Desjardin's gall-stone forceps.
Long fine aural dressing forceps or a blunt hook such as is used for
foreign bodies in the ear (*see* p. 739) may be of service. If working
without an anæsthetic, proceed very gently and make sure of a good
grip at the first attempt—a rough approach or unskilful handling
will upset the most docile patient.

It should never be necessary to remove portions of turbinal,
etc., to effect delivery. A body far back in the inferior meatus may
be pushed into the nasopharynx, where a finger awaits it and steadies
it until seized with forceps introduced through the mouth. In doing
this, first extend the head over a pillow, so that the foreign body

does not slip down the pharynx before it can be secured. A foreign body in the nasopharynx is usually most easily delivered through the mouth. Such bodies as safety-pins are, however, often fixed with the point downward, and if there is any difficulty in securing the point, they are best delivered through the nostril; to allow the point to penetrate the wall of the pharynx is to incur a serious risk.

ACUTE SUPPURATION IN THE NASAL ACCESSORY SINUSES

Clinical Memoranda.—*Pain* between or behind the eyes may result from infection of any sinus. The pain of antral suppuration is often felt above the corresponding eyebrow, and sometimes in the nape of the neck; that of sphenoidal sinusitis may be located in the ear or mastoid process of the same side. Pain from a single cell may spread over the whole affected side of the head, or to the opposite side.

Œdema is more frequent and conspicuous in children than in adults, in whom any considerable swelling suggests osteitis. Swelling of the eyelid is more common (*Fig.* 734); any material chemosis or limitation of ocular movement indicates an orbital complication (*see* pp. 781, 806-808). In antral infection the point of maximum swelling (sometimes actual pointing) is usually internal to the mid-pupil line, near the ala nasi; swelling of dental origin is ordinarily farther out. Discharge may be absent; these cases of ·closed empyema· are seldom the least severe.
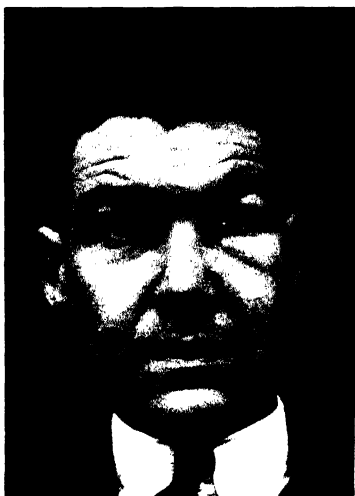
Fig. 734.—Œdema of eyelids in acute left ethmoiditis.

Pus coming over the *front* of the inferior turbinal is almost certainly from the frontal or anterior ethmoidal cells; antral discharge may appear over the middle of the inferior turbinal. But much, or the whole, of discharges even from these anterior cells may pass back under the middle turbinal into the nasopharynx. Pus reaching the nasopharynx above the middle turbinal comes from the posterior ethmoidal or sphenoidal cells; from the latter the discharge may also run down the back of the vomer. It must not be assumed that the sinus from which discharge is escaping is the only one affected, or the one causing the principal symptoms; acute suppuration is rarely limited to a single cell.

The sphenoidal sinus is rudimentary until the fifth year, the

frontal until the seventh; one or both frontals may remain rudimentary throughout life (*Fig.* 735). The antra and ethmoid cells are present at birth, and well developed by the end of the first year. Until they erupt, the permanent teeth occupy the outer wall of the antrum.
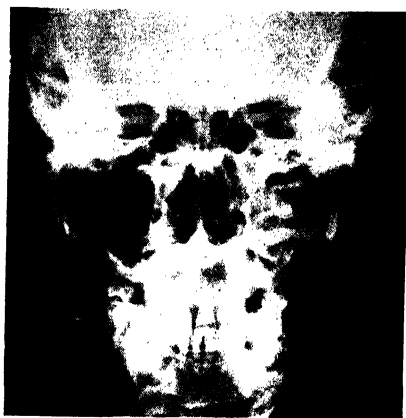
Fig. 735.— Acute suppuration of dental origin, in the left antrum of a middle-aged adult. The other sinuses are not affected. Note the complete absence of the frontal sinuses.
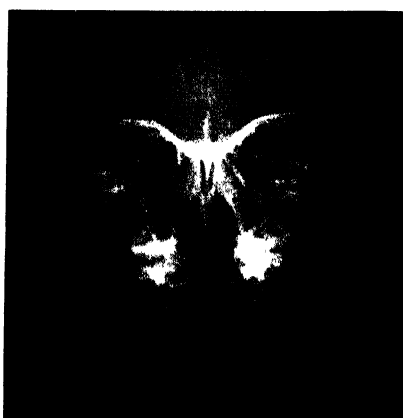
antrum an ... noid in a child of 4. Note the absenc ... ontal sinuses. The permanent canin ... py the anterior wall of the antrum, ar ... l the molars the external.
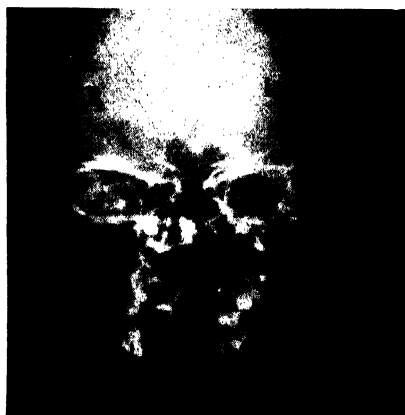
F. 737.— Acute suppuration in right ethmo d and antrum in a boy of 10. The right rontal sinus is rudimentary. The relatic of the teeth to the antrum is best seen o the healthy side (left).
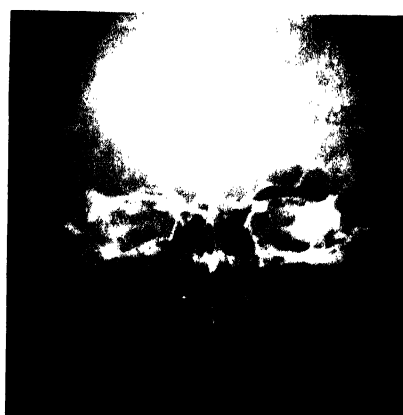
Fig. 738.— Acute suppuration in a very large right frontal sinus (opaque), which extends well to the left of the mid-line. The other sinuses are healthy. The patient was an adult.

Transillumination is of value when it shows one antrum dark ; as a method of excluding infection it is untrustworthy, especially in children.

Skiagraphy should never be omitted when the diagnosis is in doubt. It gives valuable information as to the existence, size, and shape of the various cells (*Figs.* 735–738). At times an acutely infected cell may not appear radiopaque.

Differential Diagnosis. From foreign body in the nose, suppurative rhinitis, nasal diphtheria, abscess of septum ; from dental abscess ; from eye disease, conjunctivitis, iritis, glaucoma, dacryocystitis, orbital cellulitis ; from gumma (especially frontal), mastoiditis, meningitis. A dental abscess that discharges into the nostril is specially misleading. (The condition often described as 'acute maxillary sinusitis of the new-born' is in fact osteomyelitis of dental origin, any infection of the antrum being secondary and unimportant.)

Management. If possible, avoid operating during the acute phase. Treatment should be directed to the relief of congestion and to promoting resolution. Order the patient to bed and prescribe a full dose of calomel. An adult may take tinct. quinin. ammon. ℆ xv (1 c.c.) every four hours with water, or if the headache is severe—

℞ Ac. Acetylsalicyl.	gr. viiss	(0·5 grm.)
Phenacetini	gr. v	(0·3 grm.)
Caffeinæ	gr. iiss	(0·15 grm.)

Local Treatment. Irrigation of the nose is not advisable. Once or at most twice a day the surgeon may introduce into the middle meatus a pledget of wool moistened with 5 per cent cocaine hydrochloride solution ; if the posterior ethmoid or sphenoidal cells are alone or mainly involved the wool is placed in the back of the olfactory cleft. Some care is needed to see that the solution gets right up where it is most efficacious, and that it is not swallowed ; the patient should hold the head well forward. A single drop of 1–1000 adrenalin solution may be added to each drachm (4 c.c.) of the cocaine solution ; strong adrenalin should be avoided on account of the reactionary swelling.

External *heat* is comforting and therapeutic. It may be applied continuously by means of a hot-water bottle or bran-bag ; or intermittently (*a*) as radiant heat, employing a bath of electric bulbs, the eyes being protected by shading, (*b*) by inhaling the vapour from hot water, to which may be added a trace of menthol, (*c*) by means of the diathermy current, (*d*) by ultra-short-wave therapy. Whatever the method, the duration of any application should be strictly limited to what is comfortable. Poultices and fomentations are better avoided, as they tend to obscure the evolution of clinical signs.

Children.—Some modification of the above scheme is necessary when treating young children. An alkaline febrifuge mixture should be substituted for the quinine. During the first two years of life avoid both menthol and cocaine, and with young children exercise great care with the latter. Liquid paraffin may be instilled into the nostrils by means of a dropper. When treating babies the old-fashioned steam tent is often of service.

Complications.—In addition to direct extension, suppuration may involve the orbit (p. 806) or the intracranial tissues (p. 767). Two causes of rapid loss of vision that may be puzzling are : (*a*) Thrombosis of the retinal vein ; (*b*) Canalicular optic neuritis. If symptoms of meningitis appear, the outlook is grave ; nevertheless such symptoms should be regarded as an indication for immediate surgical intervention. If an abscess points in the skin of the cheek or forehead, make every effort to avoid actual rupture here ; support the threatened area with strapping, and drain the sinus as advised below. Acute tonsillitis is the commonest complication of operation for acute sinusitis.

Indications for Operation. —

1. Definite improvement has not taken place within (at most) three days, in infants twenty-four hours.

2. Œdema is conspicuous, suggesting osteitis.

3. The disease appears to be spreading, a complication is present or threatened, or the symptoms are grave and the general condition is unsatisfactory from the outset.

4. The sinus suppuration is associated with injury to the bony walls from accident (especially frontal).

5. The acute attack has supervened on chronic disease, with polypi or other impediment to drainage.

Usually all that is needed is drainage of the affected cell or cells.

OPERATIVE TREATMENT

A general anaesthetic is necessary, and ether vapour from a Shipway's apparatus will be found convenient. The moustache should be shaved. A head-lamp or mirror arranged over the right eye, so as to illuminate the depths of a cavity, is helpful always, and a necessity when operating on ethmoid or sphenoid.

Immediately before induction spray the nose with cocaine-adrenalin solution (p. 703) or pack the affected side with gauze wrung out with the same. Use not more than 4 c.c. for an adult in either case, and be careful that it is not swallowed. For young children use 1–10,000 adrenalin without cocaine. Before beginning the operation see that tracheotomy instruments are ready. As soon as induction

is complete pack the posterior choanae with a taped gauze swab, well vaselined and passed up behind the soft palate. Anæsthesia is now maintained through a pharyngeal airway, e.g. Hewitt's.

Disinfect the skin and the interior of the nostril, especially the anterior corner, with spirit. If polypi are present they should be removed with Luc's forceps.

Drainage of the Maxillary Antrum.—

Pernasal Antrostomy. Originally advocated by John Hunter, this is the operation of choice in ordinary cases, and the only method for children. Expand the nostril with a speculum and identify the inferior turbinal low down against the outer wall of the nose ; if it comes so low as to interfere with subsequent treatment remove the head (only) in the manner described for the middle turbinal (p. 712).

Fig. 739.—Pernasal antrostomy with a gouge. The figure shows the site for opening the antrum, and (dotted) the amount of antro-meatal wall subsequently removed. Two ropes of bubbly mucopus from the antrum descend (i) over the middle of the inferior turbinal, (ii) above its posterior end.

The point at which the antrum should be entered is close to the nasal floor, and about 2 cm. back from the osseous margin of the triangular aperture. The distance is about the same in children of 7 and older ; before that age remember that the antral floor is higher than the nasal, and that a point slightly nearer the front must be selected. Here the antrum may be opened with a sharp rasp, a dental burr, or one of the special trephines or chisels made for the purpose. If

E. S. 45

a straight narrow gouge is used, pass it in beneath the inferior turbinal until the end rests on the spot indicated, and hold it as transversely as possible, pressing the tip of the nose to the opposite side. With a sharp tap cut through the bone into the antrum (*Fig.* 739) ; be careful that the gouge does not slip back along the wall, and also that it does not enter too far—the bone is quite thin. Enlarge the hole with a second cut a little farther back, and through it pass one blade of a punch forceps (e.g. the ring conchotome, *Figs.* 741, 745) to remove the posterior part of the antro-meatal wall. With gouge, rasp, or burr smooth down the edge in front and along the floor. If the sinusitis is secondary to dental disease, remove the tooth and curette the socket.

After-treatment.—No local treatment is needed until the fourth day. Then twice a day cocaine the nose (to shrink the mucosa) and irrigate the antrum with warm normal saline or with :

R   Sod. Bicarb.
     Sod. Biborat.
     Sod. Chlorid.   aā.

A teaspoonful to a pint of warm water for a nasal irrigation.

Modification : Per-oral Antrostomy (Seanes Spicer's). This route may be desired for the purpose of inspecting the mucosa or to remove

Fig. 740. Exposure of the canine fossa. The wall of the antrum has been trephined.

a foreign body ; it is not advisable in children. Retract the upper lip, pack gauze between the jaws and the airway to prevent inhalation of blood, and disinfect all exposed mucosa with spirit or with liquor iodi. Make an incision down to the bone, extending 3 cm. back from the prominence of the canine root, 1 cm. from and parallel to the gingival margin. Reflect the periosteum up, and seize in forceps the one or two vessels that may bleed freely. The canine fossa is now exposed (*Fig.* 740). The bone here is thin and easily penetrated with gouge or trephine. The lower edge of the opening should lie above the line of the incision. Open the mucosa of the antrum, mop out the blood and pus, but do not strip

the mucous membrane from the walls. Gross polypoid hypertrophies may be removed with Luc's forceps. It is found that if the operation

is stopped here a troublesome oro-antral fistula will develop; the opening into the nose described above should therefore now be made, and the mouth incision closed with one or two points of suture (silk or catgut).

Drainage of the Frontal Sinus. —

Indication. The operation of choice in uncomplicated acute frontal sinusitis.

A good skiagram showing the anatomy of the sinuses and the distribution of the disease is of great value (*see Figs.* 735 738). Anaesthesia and preparatory steps are discussed on p. 704. The eyebrow
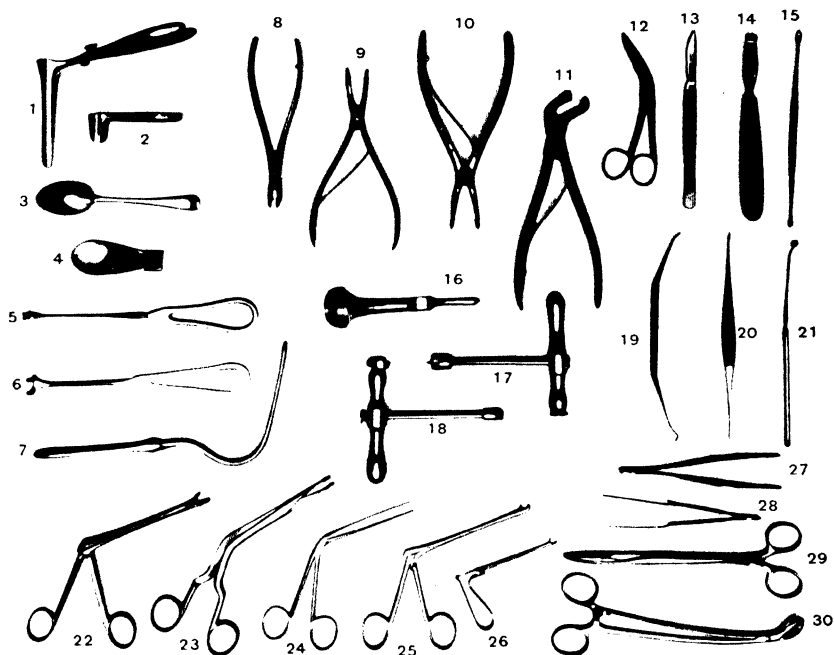
FIG. 741.—Instruments for frontal sinus operation. *1. Killian's median rhinoscope speculum; *2. Nasal speculum; 3. Teaspoon, for orbital retraction; 4. Orbital retractor; 5, 6. Retractors; †7. Tongue depressor; 8, 9, 10. Jansen's bone forceps; 11. Lombard's bone forceps; 12. Scissors; 13. Scalpel; 14, 15. Periosteal elevators; 16. Mastoid hand-gouge; 17, 18. Trephines; 19. Pus seeker; 20, 21. Curettes; *22. Ring conchotome; 23. Luc's spoon forceps; 24. Nasal packing forceps; *25. Spheno-ethmoidal forceps; 26. Granulation forceps; 27. Toothed forceps; 28. Dissecting forceps; †29. Post-nasal sponging forceps; 30. Tissue forceps. Not shown: 12 haemostats, needles, towel-clips, tracheotomy set.

* Seldom required unless the operation extends to the ethmoid.
† For introduction of pack into nasopharynx.

need not be shaved. As soon as the anæsthesia is complete the skin
of the region should be disinfected. The instrumentarium is shown
in *Fig.* 741.

Operation.—Two radial scratches are made across the supero-
internal angle of the orbit to ensure accuracy in subsequent closure.
Draw up the skin of the forehead till the eyebrow lies above the orbital
margin, and make an incision starting immediately below the centre
of the eyebrow, along the lower border of this inward, then curved
downward along the nasal margin of the orbit to a level of 1 cm. below
the inner canthus (*Fig.* 742. A). Deepen the incision down to the bone,
keeping the knife always at right angles to it. Bleeding is brisk,

A   B   C

Fig. 742.—Drainage of the frontal sinus. A, The incision, after pulling up
the skin of the forehead; B, Retraction of soft tissues, exposing the bone of the
supero-internal angle of the orbit—the site for applying the trephine is indicated;
C, The drainage tube has been placed in position and the lowest suture inserted to
secure it.

especially from the angular artery and its branches; these may be
difficult to secure until the periosteum is reflected. Begin this step
along the side of the nose, taking care not to wound the lachryma
sac. Farther up the pulley of the superior oblique will be found
just within the orbital margin at the supero-internal angle; take
care that when this is separated from the bone it is not detached from
the periosteum, otherwise subsequent diplopia is almost certain.
Having secured hæmostasis, retract the soft parts, so as to expose
the adjacent part of the orbit and the anterior face of the frontal bone
just above (*Fig.* 742. B); the bowl of a teaspoon makes a satisfactory
retractor for the orbital tissues—be careful that forceps, etc., do not
press on the eyeball. Apply a trephine of 1 cm. diameter to the
angle of the orbit, rather to the inner than to the superior wall; or
open the bone by gentle taps with mallet and gouge. The bone is

quite thin, and no force is needed. On removing the piece of bone, the mucous membrane bulges out, swollen and purple. Pack in a strip of gauze and enlarge the bone opening with cutting forceps; smooth the cut edge and rub in a trace of Bipp. Pick up the mucous membrane with toothed forceps and remove the exposed part with scissors, receiving the purulent contents of the sinus on gauze.

Irrigate the sinus gently with warm saline. It is permissible to explore the cavity gently with a probe, but the mucous membrane lining it should not be disturbed. Place a small drainage tube with the inner end inside the cavity, but not so far in that it may become blocked by swollen mucosa, and fix the outer end to the lower corner of the wound (*Fig.* 742, C). Close the incision accurately with interrupted sutures, cutting the ends short so that they do not irritate the eyeball. Apply a well-vaselined eye-pad over the eye, and secure a large dressing firmly over the whole wound.

After-treatment. The general and local symptoms should rapidly improve and the temperature return to normal or nearly so within forty-eight hours. The dressings need to be changed after this interval, and then daily. In five to eight days the discharge should become mucoid; the drainage tube can then be removed. If a mucous fistula persists, pernasal drainage should be undertaken by one accustomed to such procedures.

Obliteration of the Frontal Sinus.—

Indications. (1) Subpericranial abscess, osteitis, or actual perforation of the anterior wall of the sinus is found; (2) Sinusitis is associated with comminution of the anterior wall; (3) Symptoms persist or recur after drainage; (4) Meningitis or brain abscess is present or suspected.

The object of the operation is to remove the whole floor and anterior wall of the sinus, together with all the mucous membrane, so that the soft parts may fall together and the sinus become obliterated. If the sinus is large some deformity will ensue.

Operation. The preliminary steps follow the lines laid down for drainage of the sinus. The incision should be carried out as far as the outer end of the sinus; a second cut, across the 'spectacle line' of the nose, may be needed for adequate exposure. Strong retraction upward of the soft tissues will be needed; if both sinuses are to be operated on it is better to reflect the soft tissues of both sides at the start (*Fig.* 743). Having opened the mucous membrane of the sinus, explore its dimensions with a probe, and proceed to remove the anterior wall with strong gouge forceps. The mucous membrane should be removed together with the bone. Search carefully any suspicious place which may lead into a partly hidden loculus of the

sinus. Compare the cavity with the skiagram to be sure that no corners are overlooked.

Now fully retract the orbital contents down and outward to expose the floor of the sinus where it runs in along the orbital roof. This should be removed also, but it is thin, and careful work with Luc's or similar spoon forceps will serve. The deeper portions need the utmost circumspection. Transverse septa are rare; but the ethmoidal cells may send out orbital prolongations behind or even outside the frontal cavity, and if so these should be cleared also. When approaching the mesial part proceed with redoubled caution. The cribriform plate lies often at a lower level than the roof of the frontal or ethmoidal cells, being therefore an internal relation to these; incautious methods in this region may be disastrous.
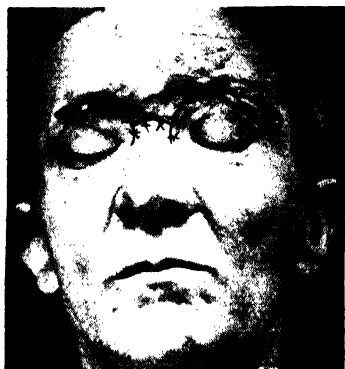
Fig. 743.—Incision for tion of both frontal sinus subcutaneous position of t can be seen.

Having fully exposed the whole sinus, remove the mucous membrane from the inner wall, working gently with gauze, granulation forceps, and curette. Remember that the bone may be less than 1 thick. Again carefully examine the bone for corners and recesses that may have escaped attention. In a large sinus there will be several sagittal septa (*Fig.* 744 *and see Fig.* 738, p. 702), which should be cut down until level with the posterior wall; when both sinuses are involved the inter-sinus septum should be thus treated, and the glabella pared down level with the root of the nose. As a general rule the posterior wall of the sinus should not be removed; examine it carefully for cracks or disease (*see belo* c, p. 711), and if it appears satisfactory dress it with Bipp well rubbed in.

Fig. 744.—Obliteration sinuses. The anterior wall ha showing the septa and the arrangement in this patient.

When only one sinus has been opened, arrange a drainage tube from the mid-line, bringing it out at the outer corner of the incision;

further drainage may be provided by a strip of rubber dam led out beside the inner canthus. If both sinuses have been opened, the two drainage tubes should overlap, and further drainage is seldom needed (*see Fig.* 743). Close the skin incisions and dress as described for drainage of the sinus.

After-treatment. —The tubes may be shortened about the sixth day, and entirely removed on the tenth if all is well. There is seldom much discharge. The patient may need a cap with a broad brim when in bright light ; any plastic restoration should be postponed for six months.

Difficulties and Dangers.

1. *The posterior wall of the sinus is manifestly diseased, or is damaged during operation.* Take a mastoid hand-gouge and, employing it as advised for the removal of the tegmen tympani (p. 758), carefully pare off the bone until the dura is reached. The latter is adherent to the bone, and care is necessary not to tear it. Gently separate the dura from the bone by packing in gauze, and remove the diseased or damaged area. When completing the operation, be sure that the exposed area of the dura is directly drained.

2. *Meningitis or brain abscess is present.* In the former case, proceed as just described, and adopt the general treatment discussed on p. 768. Brain abscess secondary to frontal sinusitis is usually quite near the surface of the brain ; having uncovered the dura, proceed as on p. 775.

3. *Spreading osteomyelitis of the frontal bone* is an extremely dangerous complication. In cases where this arises from frontal sinusitis before operation, more than half die ; while when it follows operation recovery is unusual. *Treatment* : Every measure that will support the patient will be needed —antiscarlatinal serum, intravenous injections of colloidal silver (Collosol argentum, 50 c.c. daily), and blood transfusion may be mentioned. The operative treatment consists in removal of the whole of the diseased bone until healthy, bleeding bone is reached, working on the lines laid down above. It is usually necessary to remove the whole thickness of bone, exposing the dura. As soon as the apparent margin of the disease is reached rub the edges with Bipp, disinfect the whole wound with spirit, and proceed to remove a further margin of bone. While doing this the forceps should be wiped after each bite, and then swilled in spirit to limit infection of further bone during removal. Anatomical difficulties impose limitations toward the cribriform plate. Again dress the cut bone edge with Bipp. Stitch the flap of soft tissues back so as to expose the whole wound, and dress the raw surface with eusol. If the patient recovers, plastic measures to close the wound may be undertaken in the third week. If the disease continues to spread the

operation may have to be repeated ; although the outlook is ... en very bad, recoveries have been reported after three and four operat... s.

Drainage of the Ethmoid and Sphenoidal Sinuses. The sphenoidal sinus is a cell of regular form, but difficult of access on account of its position. The ethmoid consists of a labyrinth of cells of very irregular size and shape, with thin walls and roof. Pernasal operation should not be attempted by those unfamiliar with the necessary technique. Before starting an operation, review the anatomy of the parts, preferably by reference to a skull.

ANTERIOR ETHMOID. Preparation of the patient and disinfection of the skin follow the lines laid down for drainage of the frontal sinus (p. 707). The incision should be carried somewhat farther down round the orbital margin. Having secured hæmostasis, continue the reflection of the periosteum back along the inner wall of the orbit. Take especial care not to damage the lachrymal sac, which should be turned outward out of its groove. A little farther back, and higher up, will be found the anterior ethmoidal vessels passing through their foramen –this marks the position of the (transverse) middle turbinal plate, dividing the anterior from the posterior ethmoidal cells. Pass a ligature round the vessels, and divide them externally to this.

Retracting the orbital tissues strongly outward, examine the inner wall of the orbit formed by the lachrymal bone and the lamina papyracea behind it. Frequently there will be found manifest evidence of disease, indicating the spot to attack the bone ; if not, the very thin bone just behind the lachrymal groove should be chosen. Press a sharp spoon inward against the bone, which yields readily, opening the ethmoidal labyrinth. The contents are usually a mush of thin bony plates, swollen mucous membrane, and pus. With spoon and Luc's forceps enlarge the opening until the interior can be inspected, removing the diseased contents as they are brought into view. Avoid stripping the mucosa from the roof of the ethmoid proper ; no sharp instrument or forcible manœuvre should ever be directed against the roof, which is very delicate, sometimes dehiscent. Supra-orbital extensions should be dealt with as described in obliteration of the frontal sinus (p. 709). The curette may be used freely in a forward and downward direction, and in doing this the roof of the middle meatus of the nose will be opened.

Insert a speculum in the nostril, identify the middle turbinal, and remove the head of that bone with its attachment to the lateral wall of the nose just above (*Fig.* 745). If (as is most frequent) only the anterior cells of the ethmoid are diseased, the posterior part may be left alone. The agger cells, which lie in front of the middle turbinal, are best attacked by the curette working forward. A strip of gauze passed in through the incision and drawn out through the nostril

is useful in removing remnants of bone and mucous membrane.   Insert a piece of rubber dam into the ethmoid, securing the end to the skin margin beside the inner canthus, and close the remainder of the incision. The principal drainage is into the nose.   Dress as advised for frontal sinus.

After-treatment.   Irrigate the nose from the fifth day as advised on p. 706 ; no force should be used.   The dam may be removed on the same day, and the wound allowed to close.

Fig. 745.   Removal of middle turbinal with ring conchotome.   **A,** Position of igger cells ;   **B,** Processus uncinatus bounding hiatus semilunaris ;   **C,** Bulla ethmoidalis.

POSTERIOR ETHMOID.   When the posterior ethmoidal cells involved the orbital part of the operation must be continued back behind the anterior ethmoidal foramen, and the whole of the middle turbinal should be removed.   The removal of turbinal brings into view the opening made into the roof of the middle fossa of the nose from the orbit.   Further removal of ethmoidal cells may be effected by using the curette, Luc's forceps, or the ethmoidal forceps passed through the nostril, the action being controlled by observation through the orbital wound.   If bleeding makes this difficult, pack the wound firmly with gauze ribbon wrung out with peroxide solution and wait five minutes   the time will be found well expended.

THE SPHENOIDAL SINUS can be opened by an extension of the same procedure, in those cases where a posterior ethmoidal cell overlaps it antero-externally. In other cases, or if there is any doubt, use no force ; remember that this sinus has the optic chiasma above it, the circular sinus and pituitary behind it, and the optic nerve and the cavernous sinus externally ; while the carotid buttress, protecting the internal carotid artery, lies behind the posterior ethmoidal cell. Fortunately the walls of the sphenoidal sinus are more robust than those of the ethmoid ; but the outer wall may be grooved by the optic canal (which sometimes even crosses this cell as a 'flying buttress') ; blind instrumentation within the cavity of the sinus is therefore unjustifiable. Having removed the inner wall of the ethmoid cells right back (using the conchotome, and watching its action through the wound), the anterior face of the sphenoid will be exposed. In or near the centre the ostium may be seen. If visible, pass into it the female blade of the open ethmoid forceps ; if not, press gently on the centre of the face of the bone, where it is thin, and the forceps will be found to enter without difficulty or force. Enlarge the opening by clipping with the forceps, turning these round to reach in all directions. Do not attempt to curette the walls ; drainage is all that is needed.

REFERENCE

ROY, J. N., *Jour. Laryngol. and Otol.*, 1935, July, 518.

CHAPTER XLVI

THE PHARYNX

By Eric Watson-Williams, Ch.M.

HÆMORRHAGE

The pharynx or soft palate is sometimes injured by such accidents as falling on a pipe-stem. Generally these injuries create no serious emergency, but when the tonsil region is pierced troublesome bleeding may follow. Bleeding may also occur with a quinsy, whether this has been incised or has burst spontaneously.

The Bleeding is Moderate, and troublesome only because it persists. (Hæmophilia is discussed on p. 685.) Pack into the wound a strip of gauze, which may be moistened with turpentine or with 50 per cent dextrose solution. Make sure it goes right down; if only the opening is blocked bleeding may continue, forming a hæmatoma in the wall of the pharynx. Give 20 c.c. of ' Coagulen' intramuscularly. After fifteen minutes remove the strip; if bleeding has ceased, let the patient be carefully watched during the next twenty-four hours, and the pulse be counted at half-hour intervals (to give warning of recurrence); the Fowler position is advisable. If bleeding recurs, replace the strip of gauze; give a general anæsthetic (ether) and remove the tonsil.

Clear out clots and pack the cavity with gauze, moist as before, for five minutes. The most frequent source of bleeding is the tonsillar venous plexus; tonsillectomy allows retraction of the veins. If bleeding persists, and no bleeding point is obvious, place a small gauze swab in the cavity, and stitch the pillars of the fauces over it, taking care to pick up muscle with each stitch (*Fig.* 746). Irwin Moore's needle or one similar is useful (*Fig.* 747). The swab is removed after three days. If a bleeding vessel is seen, seize it with hæmostatic forceps and ligate it; Eadie's forceps, which ' ties its own knot ' (*Fig.* 748) is very helpful, but 7-inch Spencer Wells forceps can be used. Make sure that bleeding has ceased; sometimes there is more than one vessel affected. The stream of blood may be directed from one side of the sulcus to the other, and be mistaken for a thin string of clot. The most troublesome vessels are : (1) The tonsillar branch of the descending palatine, high up on the posterior face of the anterior pillar ; and (2) The tonsillar branch of the dorsalis linguæ, on the

same surface low down near the tongue : these may escape notice until the faucial pillar is retracted.

Bleeding is so Severe as immediately to Threaten Life.— This can occur only when a large vessel has been eroded : only very rarely
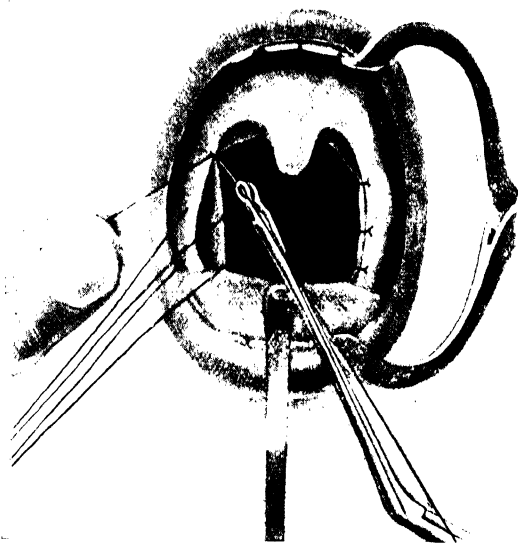
Fig. 746.— Suture of the faucial pillars, with the aid of Irwin Moore's special ligature-tying forceps. (*By kind permission from Irwin Moore's 'Tonsils and Adenoids': Heinemann.*)

Fig. 747.   Irwin Moore's tonsil suture needle.
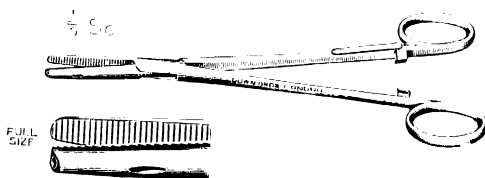
Fig. 748.   Eadie's tonsil haemostatic forceps.

will this be the internal carotid ; the ascending pharyngeal is sometimes quite large.   Be sure that the collapse is not due to vomiting of blood that has been *slowly* trickling down the gullet.   Control

the bleeding by packing, or by pressure of gauze swabs held in sponge-holding forceps against the ascending ramus of the jaw. If the loss of blood has been severe it may be advisable before resorting to other measures to wait two hours so that the patient may rally. During this time an intravenous injection of 400 c.c. of 6 per cent gum arabic solution, or of 20 per cent dextrose, may be given; or blood transfusion can be carried out (see p. 8). If bleeding cannot be controlled, or recurs, proceed at once to ligate the external carotid artery (p. 526). As soon as the main trunk has been secured, make sure that the ascending pharyngeal branch, which comes off near the origin and on the inner surface, has been included; if there is any doubt, ligate this also. If this does not *completely* control the bleeding, tie the *opposite external carotid*, which affords the only free anastomosis; it is useless to tie the common or internal carotid, unless of course the latter is the affected vessel.

Mr. V. E. Negus's Case:

Male, 47, had had acute tonsillitis and quinsy; nothing but blood followed incision of the swelling, but he improved for a week. Then there were two severe hæmorrhages, and another next day; blood was seen oozing from the upper pole of the tonsil. The tonsil was removed, and outside the capsule was a large cavity containing fresh blood and clots; a swab was sewn into the cavity, transfusion carried out, and the man made a good recovery.

Another case is reported in which the ascending pharyngeal artery was eroded; despite ligation of the external carotid of the same side, death ensued.

SUPPURATION IN THE PHARYNX

PERITONSILLAR ABSCESS: QUINSY

MANAGEMENT.—Bed; full dose of calomel. If the patient is seen early it may be possible to abort the suppuration; give an intra-muscular injection of manganese butyrate (1 c.c. of 1 per cent solution), followed by salicylates with bicarbonate pushed to the limit of tolerance. A fomentation is comforting; the supporting bandage ought to be carried over the vertex and not round the neck. If the patient can use it a gargle is helpful; the essential ingredient is water as hot as can be tolerated, with any available mild antiseptic (e.g., mercurochrome 1 per cent), employed for ten minutes every two hours. If gargling is impossible the fauces may be irrigated by means of a douche-can and tube, holding the head forward. In a severe case the patient may be nursed semi-prone, with a towel under the mouth so that saliva may dribble away to avoid the pain of swallow-ing. This position provides a measure of safety in case the abscess bursts spontaneously, but that situation should not arise.

INDICATIONS FOR OPERATION. Unless the general condition is unfavourable the surgeon should not be in a hurry to operate until a definite abscess has formed (second or third day). This is indicated by :—

1. Increase of pain on swallowing, diminution of aching and throbbing while the parts are at rest ; trismus.

2. Œdema of soft palate and uvula, with consequent muffled voice and snoring.

3. Remittent fever and leucocytosis (16,000 or more).

ANÆSTHETIC. A phlegmatic patient who can open the mouth well may allow the operation to be carried out without general anæsthesia : it is impossible by injections to anæsthetize the tonsillar sulcus, the really sensitive part. Paint the area of the incision with pure carbolic acid. The patient sits upright holding a basin, the head firmly supported by a rest or against the wall.

OPERATION.—A scalpel is prepared by winding a strip of strapping round the blade so that only 1 cm. of the tip remains uncovered. Have ready tongue depressor, sinus forceps, and a dental prop or gag (e.g., Doyen's) it is much easier for the patient to keep the mouth open and tongue down if he has something to bite on. The position for the incision is usually described as mid-way between the base of the uvula and the third upper molar tooth ; it is not constant, and the most prominent part of the swelling is the best guide (*Fig.* 749). The mucous membrane is incised with the guarded scalpel, which ought not to enter beyond the edge of the strapping. The forceps is now introduced into the wound and pushed firmly *directly backward* (not outward) ; it may be necessary to penetrate as deep as 3 cm. As soon as pus is encountered the forceps is widely opened and withdrawn. This manœuvre is painful. The patient should be allowed at once to bend forward and to spit out the blood and pus. Local after-treatment consists in frequent hot gargles ; iron internally is of value.

Fig. 749. Peritonsillar abscess, showing site of incision.

With a nervous patient or when trismus is present a *general anæsthetic* is necessary, and to secure proper relaxation ether is desirable. The patient is placed in the supine position with the head fully extended over a pillow, and turned to the affected side. When the abscess is opened the pus must be rapidly mopped up to prevent inhalation, against which the position described is an additional safeguard. Have tracheotomy instruments ready.

DIFFICULTIES AND DANGERS.

1. *Pus is not Found.* Exclude parapharyngeal abscess. In many cases the incision gives relief even without opening the abscess; and often the pus will find its way through the incision during the next few hours.

2. *Laryngeal Œdema* is rare: it may occur before the abscess is opened, and usually subsides rapidly when this has been done. Tracheotomy may be needed.

3. *Hæmorrhage* (see p. 715).

PARAPHARYNGEAL ABSCESS

This is a suppuration in the bucco-pharyngeal aponeurosis behind the palatopharyngeus muscle and posterior faucial pillar. In clinical features it resembles a peritonsillar abscess, but there is little or no œdema of the palate, and the recess behind the posterior pillar is obliterated by the swelling. It should be suspected when a quinsy appears to run an anomalous course, or when incision in the usual site fails to locate pus. The abscess tends to point rather low in the pharynx, behind the faucial pillar and level with the inferior pole of the tonsil. In view of the grave possibilities if the suppuration extends outward, or down the deep planes of the neck, it should be opened as soon as the surgeon considers that there is pus present.

OPERATION. A general anaesthetic is necessary: the instruments and position of the patient are as for peritonsillar abscess. The mouth having been well opened, the finger-tip is passed to the position described, and will usually detect a gap in the submucous tissues. Pressure outward here will readily open the abscess. Only a really blunt instrument is permissible, such as a round-ended tracheal dilator or a tongue depressor; often the gloved finger will suffice.

RETROPHARYNGEAL ABSCESS

Acute Retropharyngeal Abscess. Most common in children under four years old. The swelling is on the posterior wall of the pharynx: often it is rather low down and only to be seen when the base of the tongue is firmly depressed. Sudden asphyxia may occur.

OPERATION. A scalpel is guarded as described for peritonsillar abscess. Tracheotomy instruments should be ready. In infants with respiratory embarrassment it is unwise to give an anaesthetic. The child is wrapped tightly in a towel to facilitate control, and held upside down by one nurse, while another steadies the head. The surgeon holds the scalpel in the right hand, the back lying along the extended index finger, which acts as guide and guard. The mouth is widely opened with the gag; this may completely arrest breathing. Finger and scalpel are passed back along the tongue, pressing

this upward (i.e., toward the chin) until the finger reaches the swelling (*Fig.* 750) : the blade is now pushed boldly on in the mid-line into the abscess. As much as an ounce of pus may escape. A careful watch should be kept for forty-eight hours : the dyspnœa due to the swelling is immediately relieved, but secondary œdema of the larynx is not unknown.

In older children where there is little or no dyspnœa, ethyl chloride anæsthesia may be employed, the position of the patient being as for peritonsillar abscess. As soon as the child is anæsthetized, open the mouth with the gag, seize the tongue with a tongue- or towel-clip and draw it forward. A tongue depressor is useful in exposing a low abscess. The abscess is opened as before described, taking care that all pus is mopped up at once to prevent inhalation. An additional precaution is to aspirate the abscess before incision.

Fig. 750. Retropharyngeal abscess, showing how it may produce acute obstruction of the larynx. The figure shows also the method of opening the abscess, for which purpose the baby is held upside down.

Chronic Retropharyngeal Abscess. —Retropharyngeal abscess secondary to Pott's disease of the cervical vertebræ should not be opened through the pharyngeal wall. The correct treatment is to make an incision behind the sternomastoid muscle and by deep dissection to mobilize the carotid sheath anteriorly. Continuing blunt dissection toward the mid-line, the abscess cavity will be reached behind the pharynx. Once the pus has been evacuated, mop the cavity dry with gauze, swab the walls with liquor iodi, and close the incision completely.

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CHAPTER XLVII

FOREIGN BODIES IN THE AIR-PASSAGES.

FOREIGN BODIES IN THE LARYNX

THE treatment of acute laryngeal obstruction is discussed under TRACHEOTOMY, p. 519.

A foreign body not sufficiently large to cause complete obstruction of the larynx may cause local pain, repeated attacks of spasm, coughing, and grave distress; between the attacks the patient is hoarse, and may be unable to phonate. In mild cases these may be the only symptoms, and the presence of the foreign body may not be suspected: but pain accompanying any attempt to swallow may cause even fluids to be refused. In young children there is sometimes no history to guide one in diagnosis. Irritation may lead to laryngeal œdema and threatened suffocation.

Differential Diagnosis. From acute laryngitis, diphtheria, and spasm. It must be borne in mind that an object supposed to be 'swallowed' may really be in the nasopharynx, where its presence may cause pain referred to the throat.

Management. Have a tracheotomy set *ready*. Unless the patient is too young, examine the larynx by means of a mirror. Those skilled in the necessary technique may succeed in removing a foreign body by this means: in unpractised hands there is risk of serious damage. Direct laryngoscopy affords the most convenient and safe method of removal in nearly every case. Skiagraphy is seldom of service.

Direct Laryngoscopy.

INDICATIONS. (1) For the examination of the larynx when the indirect method fails; (2) For the removal of an impacted foreign body; (3) In treating any laryngeal obstruction, e.g., in diphtheria, where it replaces tracheotomy.

ANÆSTHESIA FOR DIRECT LARYNGOSCOPY AND BRONCHOSCOPY. — *Local anæsthesia* is preferred by the skilled bronchoscopist. *General anæsthesia* is advisable in the great majority of cases when the surgeon without special experience is called upon to deal with an inhaled foreign body it is highly important that everything should proceed without hurry or fuss. Ether vapour from a Shipway apparatus is the most convenient method; oxygen-ether entails a real risk of explosion. Before starting the anæsthetic make sure

that the tracheotomy instruments are *ready*.   A full dose of atropine
is advisable, but morphine should be avoided.

Infants : Children under three years old can be examined by
the direct method without any anæsthetic.

Contra-indications : With severe respiratory distress the best
plan is to perform tracheotomy under novocain anæsthesia.   If the
obstruction is in the larynx a general anæsthetic to facilitate
laryngoscopy can now safely be given ; while if it is in the bronchi
a bronchoscope can be passed through the wound without further
anæsthesia.
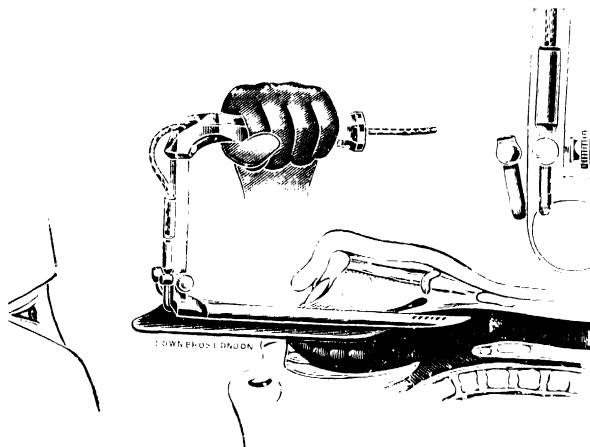
Fig. 751.—Author's laryngoscope.
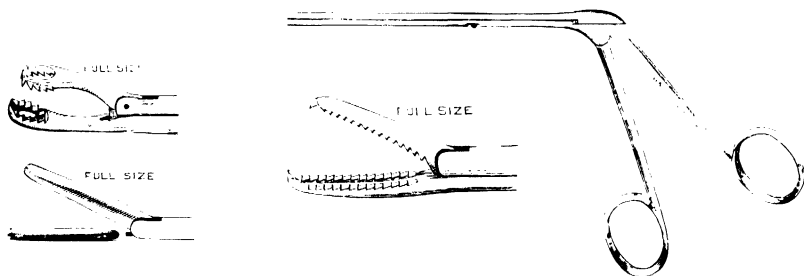
Forceps for use with laryngoscope.

INSTRUMENTS.—The laryngoscope consists of a metal rect-
angular ∪, of which one leg forms the handle (*Fig.* 751).   The other leg
is tubular, the tube being prolonged forward into a blunt beak ; a
slot in the right side facilitates instrumentation.   A small lamp near

the distal end illuminates the larynx : duplicate and alternative systems are advisable. See that the forceps for grasping the object is long enough to project beyond the end of the tube and that the ends close tightly (*Fig.* 752). Arm six wool carriers, taking care that the wool is firmly fixed.

THE OPERATION.—Darken the theatre, or at least exclude direct sunlight. Place the patient in the supine position with the head extended over the edge of a pillow. Pass the laryngoscope back along the dorsum of the tongue, identifying in turn the uvula and then the epiglottis (*Fig.* 753, A). Insert the beak behind the latter and hook it forward (*Fig.* 753, B). In doing this a lifting movement is needed : the teeth are not to be used as a fulcrum. Additional room may be
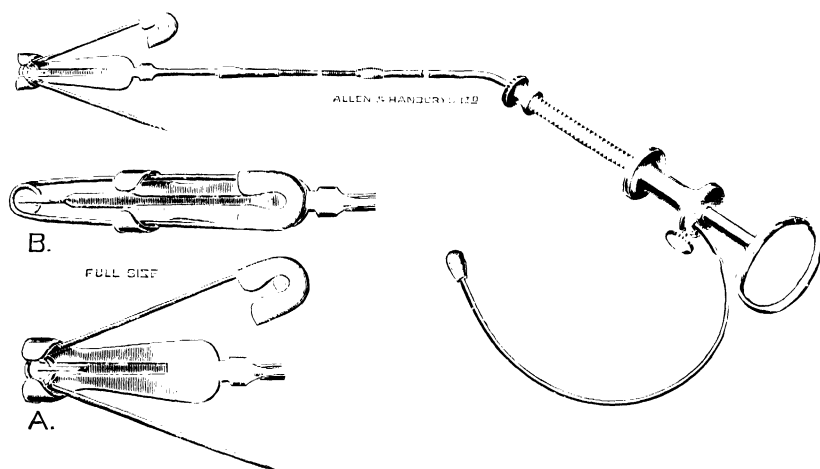
Fig. 754. Closer for safety-pin.

gained by turning the head to the left side and passing the tube through the right corner of the mouth. As the epiglottis is lifted forward the whole larynx comes into view : gentle pressure on the pomum Adami may be needed to reveal the anterior commissure (*Fig.* 753, C). If there is much spasm (except in infants) paint the cords with a wool mop, moist, but not wet, with a 20 per cent solution of cocaine hydrochloride.

The actual removal of the foreign body usually presents little difficulty. Gentleness is the first desideratum ; where hooks or points are concerned the greatest patience may be required to effect release without lacerating the mucosa. If the object is too large to extract through the tube, withdraw tube, forceps, and foreign

body together; the beak of the tube should be employed to cover any sharp point during withdrawal. In certain cases there may be difficulty in extraction upward, e.g., safety-pin point up: if the special 'closer' (*Fig.* 754) is not available, perform tracheotomy and deliver the pin through the wound.

AFTER-TREATMENT. A watch should be kept for at least forty-eight hours for laryngeal obstruction from œdema, and the patient not allowed to pass out of reach until the larynx is quite healed.

Author's Case.

A child of three choked while eating an egg. After this, although there was no dyspnœa, there was an audible respiratory stridor and the child refused to take any food or drink or to speak. An occasional hoarse cough was noted; general condition quite satisfactory. Thirty-six hours later a laryngoscope was passed without anæsthesia, when a large piece of egg-shell was seen lying antero-posteriorly between the vocal cords, and firmly impacted. It was removed with forceps; recovery uneventful.

FOREIGN BODIES IN THE TRACHEA

Anatomical Summary.—

DIMENSIONS OF THE TRACHEA AND BRONCHI IN THE
AVERAGE ADULT MALE

Length	11 cm.	2·5 cm.	5 cm.
Internal diameter*	17 mm.	16 mm.	13 mm.
Angle with vertical		25	45°–50°

The dimensions in the female are about 10 per cent less; those of children are given on p. 732. During swallowing or on extending the neck the trachea becomes longer, and slightly narrower. The surface markings in the adult male and corresponding spinal levels are indicated in *Fig.* 755.

With a long neck the cervical portion of the trachea may be correspondingly longer, and vice versa. In children the whole trachea is somewhat higher, both ends at birth being opposite the inter-vertebral disc next above that of the adult position. Owing to pressure of the aorta the lower third of the trachea is inclined slightly to the right; but the carina lies to the left of the tracheal axis. For this reason, and owing to the larger size and vertical direction of the right bronchus, the latter is entered by inhaled foreign bodies three times as often as the left.

Clinical Features. The lumen of the trachea being (except in early infancy) greater than that of the cricoid, a foreign body that has passed the latter will not completely obstruct the former unless

it undergoes alteration in shape or size. Such a case is that of the toy balloon, inhaled during an attempt at inflation. Expiratory efforts inflate the balloon in the trachea. The cardinal sign is '*silent tracheotomy*': although the trachea has been opened *no air enters or leaves even during artificial respiration*. Without delay explore the trachea with sinus or hæmostatic forceps; with good fortune the intruder may be seized and withdrawn; there may be more than one piece.
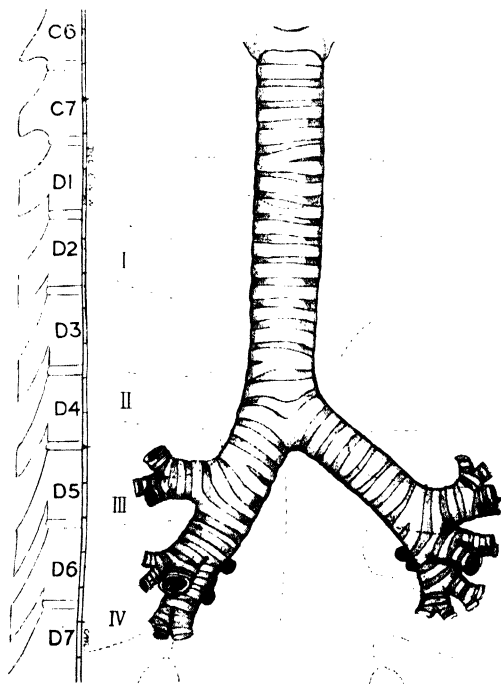
Fig. 755. —The trachea and bronchi in the adult male, showing surface markings with corresponding spinal levels. Scale of centimetres.

A. J. Wright's Case. —

An adenoid curette was used, but no adenoids removed. Respiration at once ceased and was not resumed. Tracheotomy was performed; even with artificial respiration no air entered the lungs; this distinguished the case from one of anæsthetic overdose. Forceps were passed down, and a large mass of adenoids was removed from the bifurcation of the trachea; the child recovered.

Very small foreign bodies seldom remain in the trachea but pass into the bronchi. A larger object, if smooth, may lodge in the trachea (usually at the bifurcation) or in one of the bronchi, without being

tightly impacted. The spasm that marked the entrance gives way to a period of calm, often delusive; a cough or change in position of the patient may cause the body to be thrown up against the glottis, with renewal of spasm. The patient's anxious expression and rigid immobility testify that the danger is appreciated. He wants to be left perfectly still in the position of greatest ease, generally leaning forward with the arms supported and the head bowed. Respiratory movements and talking are reduced to the minimum. There may be dyspnœa, and an 'asthmatoid' expiratory wheeze, best heard at the mouth.

Small bodies may become fixed in the trachea by points or hooks. At first there may be no symptoms after the initial choking; but tracheitis may ensue (especially with organic bodies), with severe dyspnœa from swelling of the walls and tenacious secretion.

Management.—Tracheal obstruction is (obviously) far more immediately dangerous than bronchial; the patient is in real peril. He should on no account be left alone even for a moment. As soon as arrangements can be made a bronchoscope should be passed and removal effected. The technique is the same as that for bronchoscopy (p. 730). A skiagram may help, but in many cases the object is transradiant.

Indications for Immediate Tracheotomy.—Tracheotomy should be performed: (1) If the surgeon cannot remain within call; (2) If it is necessary to transport the patient by road or rail; (3) If the patient is under 3 years old. Remember to *search for the foreign body as soon as possible*, even when it is said to have been removed. The mortality of untreated foreign bodies in the air-passages is over 40 per cent; with tracheotomy this is halved. Foreign bodies treated by broncho-scopy should not show a higher mortality than 7 per cent, and in the hands of an expert 98 per cent of recoveries are obtained.

Author's Case.—

A baby of 15 months choked while eating fish; the mother hooked up a fish-bone, and the child appeared quite normal that day and the next. On the third day he was ill and fretful, and in the evening began to have respiratory distress. He was brought to me at midnight, looking very ill; too weak to cry or cough; T. 96·2 F., R. 44, P. 140; severe inspiratory and somewhat less expiratory stridor, with bubbling sounds; tissues of root of neck, and ribs, sucked in with inspiration. Diagnosis: laryngeal œdema. No anaesthetic could be used; a laryngoscope was passed and the larynx appeared normal; a tube passed into the trachea sucked out much frothy, viscid mucus, but respiratory distress was increas-ing, so tracheotomy was performed. After cleaning the trachea by suction, examination (before inserting the tube) showed a spicule of fish-bone. This was seized and removed; it proved to be one limb of a vertebral body with two 'ribs' attached, each over 1 cm. long, and at right angles. Recovery.

FOREIGN BODIES IN THE BRONCHI

Clinical Features. — There may be no characteristic history. The symptoms produced by a body of small calibre in a main bronchus may be very few : cough, râles, and local pain are probable (*Fig.* 756).

When the body is large enough to produce appreciable obstruction there may be still no dyspnœa during rest. An 'asthmatoid' wheeze on expiration may be heard best at the mouth.

With a still larger body there is intermittent obstruction during expiration only ; air can enter the lung, but cannot leave, and the organ becomes emphysematous. The mediastinum is displaced to the healthy side, and the diaphragm does not rise in expiration on the affected side (*Figs.* 757, 758).
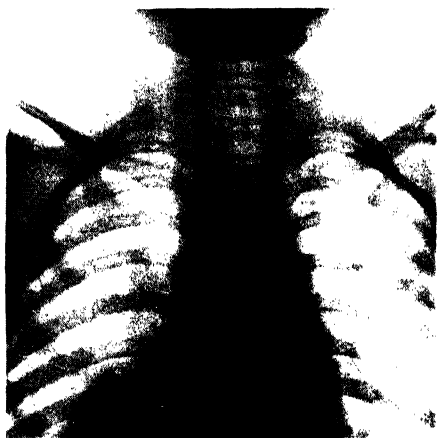
Fig. 756. Skiagram showing safety-pin in bronchus
(*By kind permission of Mr. D. A. Crow.*)

If the body is large enough completely to obstruct the main bronchus the lung is thrown out of action. At first there is severe dyspnœa, but compensation is soon established, and within a few hours there may be no distress while at rest. The air in the affected lung is absorbed, leading to atelectasis ; the diaphragm does not descend on that side during inspiration, the opposite lung expands, and the mediastinum is displaced toward the affected side.

When only a secondary or smaller bronchus is affected the disturbance may be slight, and the physical signs few : localized bronchitis or broncho-pneumonia are simulated.

Inorganic bodies cause relatively little reaction, but may remain mobile and pass from one part to another, with corresponding changes.

Organic bodies produce early and severe inflammation, with swelling of the walls, fever, and foetid purulent sputum. Vegetable substances may absorb moisture and swell. Thus obstruction at first incomplete may become intermittent and finally complete. If there is no definite history the possibility of a foreign body is readily overlooked, the condition simulating progressive pulmonary disease.

Differential Diagnosis.—From asthma, bronchiectasis, abscess of the lung, etc., foreign body in the gullet.

Management. Clinical examination will elicit signs corresponding to the conditions indicated, e.g., changes in resonance, breath-sounds, position of apex beat, etc. Skiagraphic examination should be undertaken in every case. The majority of foreign bodies are transradiant, but valuable evidence of lung changes may be obtained. If the body is opaque, two skiagrams should be taken, antero-posterior and lateral. Reference to the surface marking (*see Fig.* 755) enables the surgeon to locate the foreign body; allowance for parallax is necessary unless the object lies in the centre of the field. The changes produced by very small bodies may be so limited as to escape detection either clinically or by X rays; where the history is definite an exploratory bronchoscopy should be undertaken.

Having determined the presence and as far as possible the situation of the foreign body, the question of treatment will arise. The method of choice is bronchoscopic removal without delay. Where there is no possibility of this, the only course is to perform tracheotomy and await events.

Bronchoscopy. —

INDICATION.—A foreign body is known or is suspected to be in the bronchi.

A bronchoscopic search for a foreign body is not to be lightly undertaken. Safety and success are directly proportional to experience. The patient's interests are best served by : (1) Bringing to him a bronchoscopic team ; or, if that is impracticable, by (2) Taking him to the team. If neither course is possible the surgeon without special experience of endoscopic technique may have to undertake treatment ; in a highly civilized country this will seldom be necessary.

ROUTE. The next question is whether to pass the instrument through the larynx (high bronchoscopy) or through a tracheotomy wound (low bronchoscopy). The natural route is selected, for obvious reasons, by those who have had opportunities of acquiring technical facility. Direct laryngoscopy is first carried out and the cords are cocainized. The bronchoscope is then passed in exactly the same manner as far as the larynx, taking care to protect the upper teeth. When the vocal cords separate in inspiration the tube is slipped

FIG. 759. Upper bronchoscopy. A, Introduction of the bronchoscope; B, Entering the larynx; C, Entering the right bronchus. Note how the left hand prevents pressure on the upper teeth.

between them and the trachea and bronchi are explored (*Fig.* 759).
Those who have not had experience of this method are advised to
examine the bronchi via a tracheotomy incision; this allows of a
somewhat wider tube being used, and it need be only half as long
as in upper bronchoscopy. The patient's head is kept fully extended,
to avoid the chin interfering with the operator (*Fig.* 760).

Fig. 760. Lower bronchoscopy.

INSTRUMENTS.— The bronchoscope is a metal tube of length
and calibre suitable to the age of the patient (*Fig.* 761).
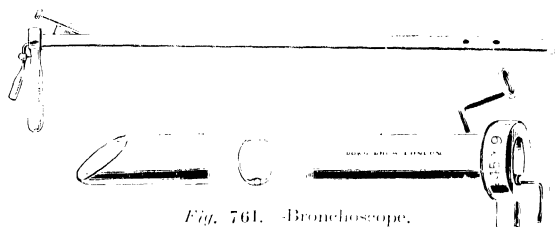
Fig. 761. Bronchoscope.

SIZE OF BRONCHOSCOPE IN RELATION TO AGE OF PATIENT

AGE IN YEARS	LUMEN OF TRACHEA	BRONCHOSCOPE*	
		Lumen	Length
	mm.	mm.	cm.
At birth	3	—	—
1	5	4	30
3	7	6	35
7	9	7‡	40
14	14	9‡	40

* For upper bronchoscopy; in lower bronchoscopy a tube of half the length will suffice.
† Also for smaller bronchi of adults.   ‡ Standard tube for adults.

Near the distal end the wall is pierced by a number of lateral holes, by means of which respiration can be continued through the healthy bronchus while the instrument is engaged in the obstructed bronchus. Illumination is provided by a small lamp near the distal end. In an emergency a bronchoscope may be improvised by carefully smoothing the end of suitable copper tubing, and fitting a handle — I still possess a tube made in this way in little over an hour, and used with success; illumination was by means of a forehead lamp. A direct-vision cystoscope may serve, or a large-bore metal catheter may be adapted for this use. Fine tubes are needed to pass through the bronchoscope to aspirate secretions, and fine forceps on slender stems are necessary for intrabronchial manœuvres (*Fig.* 762).
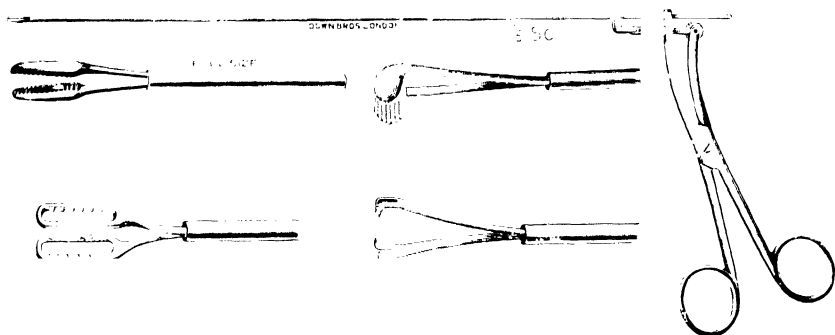
ANÆSTHESIA AND ILLUMINATION AND TESTING OF INSTRUMENTS. — These are discussed under DIRECT LARYNGOSCOPY, p. 721. Unless the known position of the foreign body negatives all *possibility* of need, have an œsophagoscope ready as well; a foreign body in the gullet may cause severe dyspnœa.

OPERATION. The first essential for bronchoscopy is gentleness. In very few cases is the patient threatened with immediate death by the mere presence of the body; to take risks in attempting removal is quite unjustifiable. With a small baby, limit the intervention to fifteen minutes *by the clock*; with an adult to thirty. A second attempt is less dangerous than a single prolonged operation.

Having entered the trachea, remove all secretions by suction; or if wool mops are used, proceed with great caution lest the foreign body be driven deeper down. See that the tube is directed straight down the lumen, and if necessary alter its direction—never lever the trachea into line with the instrument. When the lumen can be seen in line with the tube, pass the latter farther down, keeping the left-hand wall in view; it is easy to pass the tube into the right bronchus without realizing it unless this is done. Use no force, and

keep the eye always at the instrument while the latter is being moved ; it is not difficult to over-ride such a body as a pin, or even to drive it through the wall of the viscus.

After passing the bulge of the aorta in the left wall, the carina appears as a conspicuous white ridge rather to the left of the tracheal axis (*Fig.* 763, B). The right bronchus is entered with great ease. To enter the left bronchus it is necessary to carry the proximal end of the tube well over to the right. (In upper bronchoscopy, the patient's head must be turned well to the right.) All the time that the tube is being passed, keep the lumen clear by aspiration or by gentle mopping ; it is not justifiable to push on blindly into a pool of mucus.
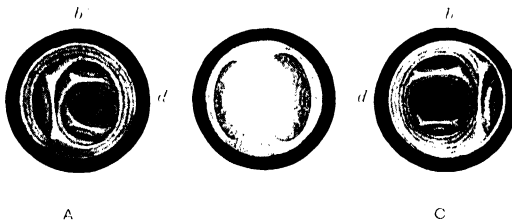
Fig. 763.— Endoscopic appearances of bronchi (enlarged). A. Left bronchus ; B. Carina ; C. Right bronchus. *a*, Eparterial bronchus ; *b*, Middle lobe bronchus ; *c*, Dorsal lower lobe bronchus ; *d*, Main lower lobe bronchus ; *a'*, Superior upper lobe bronchus ; *b'*, Ventral upper lobe bronchus.

The right main bronchus (*Fig.* 763, C) shows quite near its origin the opening of the eparterial bronchus (*a*). When this has been passed we see close together three openings : the ventral opening of the middle lobe bronchus (*b*) ; the posterior opening of the dorsal lower lobe bronchus (*c*) ; and the main lower lobe bronchus leading nearly straight on (*d*).

The left bronchus (*Fig.* 763, A) gives off no branches until it breaks up into four secondary bronchi almost at one level. The opening to the left is that of the superior upper lobe bronchus (*a'*) ; on the ventral wall is the opening of the ventral upper lobe bronchus (*b'*) ; slightly further on is given off the dorsal lower lobe bronchus (*c*) ; and the main lower lobe bronchus continues straight on (*d*).

The sizes of endoscope given above will enable the operator to explore as far as has been described, beyond which point it is not very often necessary to proceed. If the foreign body cannot be found, see whether there is pus or excess of secretion in one of the branches ; this often indicates the site of the intruder. Secure a good grip of the foreign body before attempting removal. A pin needs to have the point (if upward) brought within the tube before extraction. A staple can sometimes be turned in the bronchus so as to extract it with the points trailing. A glass bead is very troublesome to

grip ; go carefully, lest it be driven further on, perhaps out of reach. Sometimes a blunt hook may be useful to steady the body for seizure. Vegetable substances tend to break up under the forceps ; endeavour to remove at least all large pieces.

DIFFICULTIES AND DANGERS. —

1. *The Foreign Body Cannot be Found.* —Unless there is no possibility of impaction in the œsophagus, examine this region.   If this does not solve the problem, proceed as in (2).

2. *The Foreign Body Cannot be Reached or Removed.* —Keep the tracheotomy wound open as long as the body remains in the lung : it may be coughed up after an interval.   Consider whether the patient should not be transferred to a centre where specialist services are available.   A retained foreign body usually leads to bronchiectasis, and the prognosis is poor ; lobectomy offers a reasonable alternative.

When in difficulties with an object opaque to X-rays arrange a second search on the X-ray table ; an assistant indicates the direction.

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CHAPTER XLVIII

THE EXTERNAL EAR

By Eric Watson-Williams, Ch.M.

Hæmatoma Auris. This consists of an effusion of blood beneath the perichondrium of the concha; it may occur spontaneously even in the young and healthy, tends to recur after evacuation, and if untreated leads to the unsightly deformity known as 'cauliflower ear'.

TREATMENT.— Local anæsthesia with novocain-adrenalin injection is often sufficient, though for a child or nervous adult a general anæsthetic may be needed. An incision about 2 cm. long will enable the operator to evacuate the blood and any clot present. Firm pressure for several minutes may be necessary to control oozing; if this does not suffice, pack in for ten minutes a pledget of wool wet with coagulen or with 50 per cent glucose solution. The skin incision should not be sutured. The ear must be well supported front and back by gauze dressings and a firm bandage applied for three days; additional support can be given by immersing the dressings before application in melted hard paraffin (ambrine).

Suppurative Perichondritis.—This occurs from suppuration in a hæmatoma, and in typhoid, variola, etc., and after operations such as the radical mastoid (*Fig.* 764).

Fig. 764. Suppurative perichondritis of the auricle

TREATMENT.— A general anaesthetic is usually desirable. The abscess must be opened without loss of time, at least one incision on each surface of the concha going down through perichondrium. It is well to warn the patient that there may be subsequent deformity even with early treatment.

Illumination in the Immediate Surgery of the Aural Meatus.— In all operative manoeuvres in the meatus brilliant illumination of the whole field is essential. An illuminated magnifying operating auriscope (*Fig.* 765) is a great advantage. If a head lamp or mirror is used it must be arranged over the right eye; a lamp in the centre of the forehead will not illuminate the visible part of the fundus.

END VIEW
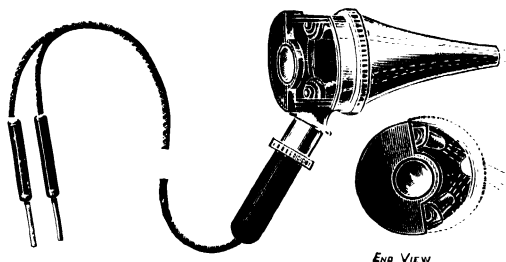
Fig. 765. The author's operating auriscope (illuminated and magnifying.) (× ⅔.)

Foreign Bodies in the Ear. Remember that a small object near the membrane may be hidden by the curve of the meatal floor. A living intruder, such as a spider or ant, may cause the most acute distress by the sensation and sound of scratching or wriggling, and may cling with claws so firmly as to defy syringing. Blow chloroform vapour into the meatus for five minutes before using the syringe. Ticks or maggots (e.g., screw-worm) in the meatus cause intense pain by their cutting movements, and have even been known to expose the brain. In the intervals between movements a slight bloody discharge may be the only symptom. A drop of turpentine or of chloroform (both very painful) will kill these, or one per cent solution of chloroform in water may be used for syringing.

A mass of hard wax impacted in the fundus may grow by accretion of layers of desquamated epithelium (keratosis obturans), producing sufficient pressure to cause destruction of bone, exposing perhaps the facial nerve, or pushing the stapes inward. The resulting symptoms, ear- and head-ache, facial paralysis, vertigo, nystagmus, and vomiting may raise suspicion of labyrinthitis or brain abscess. The following drops will soften such a collection :—

R   Sodii Bicarb.   gr. x (2 parts)
    Glycerini   ʒi (12 parts)
    Aquam   ad ℥j (to 100 parts)
    F. gutt. tres dies ter in die in aurem instillendæ

E. S. 47

SCHEME OF TREATMENT. (1) Syringing; (2) Instrumental removal; (3) The same, under general anæsthesia; (4) The same, after turning the ear forward; (5) Enlargement of the bony meatus with the gouge. As soon as a fair trial of one method has proved ineffectual the surgeon should proceed at once to the next; an obvious corollary is, that before *any* operation under general anæsthesia is started all preparations must be made to go on to enlargement of the meatus if requisite.

In all instrumentation within the meatus the greatest care and gentleness is imperative; rough or unskilful methods carry a definite risk of dislocation of ossicles and even of producing labyrinthitis. Manifestly, the patient must remain absolutely still throughout the procedure, and suitable support for the head should be arranged in every case.

1. Unless the object is firmly impacted or fixed by points, removal can usually be effected by *syringing*. The syringe should be capable of delivering a fine jet with considerable force, and the water must be warmed to 100° F. (38° C.) to avoid giddiness. Inspection will show if there is a chink at one side of the foreign body, and the jet should be directed along the meatal wall toward this chink, the aim being to swill out the body by the force of water behind it. Draw the pinna outward and a little backward, which straightens the meatus. One need not fear the swelling of peas, beans, etc., as they become soft at the same time, and can be broken up with a probe in a day or two if the original syringing is ineffective.

2. When syringing does not dislodge the foreign body, resort must be had to *instrumental removal*. The majority of foreign bodies that need this are of the nature of pebbles or beads that elude the grasp of forceps. It may be possible to cause such an object to adhere to a match-stick the end of which is armed with a small drop of fish-glue ('seccotine'); time must be allowed for this to harden before attempting removal.

The most generally useful instrument is a fine blunt rectangular hook; grasping forceps may be necessary as well (*Fig.* 766). Under good illumination the end of the hook is gently insinuated between the meatal wall and the object, turned, and withdrawn, bringing the intruder with it; several attempts may be required.

3. If this fails, a *general anæsthetic* is necessary. There should be no hesitation in advising anæsthesia when the patient is too young or too nervous to co-operate with the surgeon, or when tight impaction renders even a docile patient intolerant. Be sure before starting that you are ready to go on to open operation if necessary. Often, however, the additional facility conferred by the anæsthetic will lead to a successful removal *per vias naturales*.

4. When the object cannot be dislodged even thus, *the ear should be turned forward* as if for the Schwartze operation (p. 749). The periosteum is divided and reflected forward (not back), and detached from the posterior margin of the meatus and the spine of Henle. The posterior meatal skin is now pressed forward and incised vertically over the foreign body as near the level of impaction as possible, thus bringing the object into view in the fundus through the wound. The mechanical advantage thus obtained may enable the operator to effect removal.
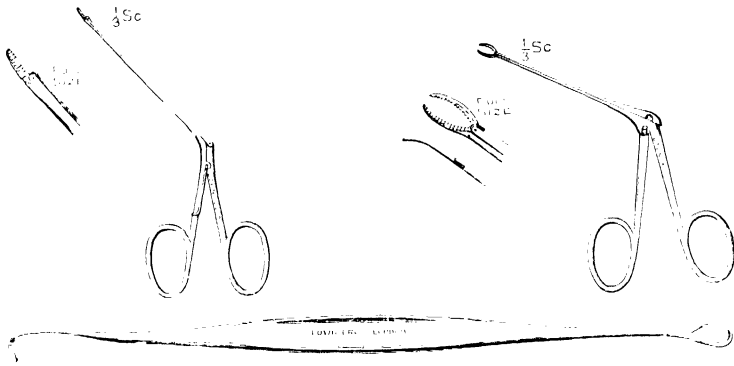
Fig. 766. Aural forceps and hooks.

5. If this is still impossible, take a narrow gouge, and applying it about 1 mm. behind the meatal margin, with gentle taps of the mallet enlarge the circumference of the bony meatus. The gouge should be directed almost parallel with the meatal wall; not more than a millimetre of bone need be removed, nor ought the removal to be carried deeper than the level of impaction. Great care must be taken that the gouge does not pass deeply, and also that the foreign body is not driven farther in. When this has been released, suture the ear in place, and pack the meatus with gauze anointed with paraffinum molle; closure of the meatal incision is unnecessary.

Rupture of the Tympanic Membrane. *Avoid syringing and the use of peroxide.* The less that is done the better; the fundus is normally sterile. If bleeding has ceased, do not disturb the clot on the membrane, but disinfect the skin of the cartilaginous meatus with liquor iodi mitis or with 1 per cent aqueous solution of mercurochrome. If bleeding continues, clean the meatus with dry sterile wool, and disinfect the whole. In either case apply a sterile dressing to cover the ear, and watch for evidence of infection (*see* p. 741). *Severe bleeding* may come from the lateral sinus or from the middle meningeal artery (pp. 478–487).

Furuncle of the Auditory Meatus. While a furuncle of the outer half of the meatus may be almost symptomless, one in the deeper parts can be excruciatingly painful. In any early case examination will show a localized swelling of the meatal wall. Remember herpes, meatal exostosis, and granulations from antral cholesteatoma eroding into the meatus. Later, tenderness and œdema may render otoscopy impossible. When post-aural œdema or lymphadenitis coexists a close resemblance to mastoiditis may be produced. The differential diagnosis may be tabulated thus :—

			MASTOIDITIS
Age	..	Rare in children ..	Common in children
History	..	Furuncles elsewhere	Otitis media, coryza, exanthem, bathing, teething, etc.
Other disease	..	Perhaps glycosuria	Adenoids, nasal infection
Fever, malaise	..	Seldom severe	May be severe ; not always
Early tenderness	..	Typically greatest over tragus	Usually post-aural
Meatal œdema	..	May occur anywhere and occlude orifice	Postero-superior and confined to fundus
Membrane	..	Usually normal	Injected or perforated (rarely normal)
Hearing	..	Normal if meatus clean	Usually impaired
Discharge	..	Scanty, purulent	Muco-purulent, often profuse

TREATMENT. In a mild and early case give the patient a full dose of calomel, and if it is available an intramuscular injection of manganese butyrate, 0·01 grm. Apply a large fomentation to the ear, and instil into the meatus every four hours 10 per cent ichthyol in glycerin as hot as can be borne. By mouth, stannoxyl thrice daily ; twelve tablets a day is a full adult dose.

Operation is indicated if pain is severe, or if the treatment does not relieve within forty-eight hours. Anæsthesia and preparation follow the lines indicated for paracentesis tympani (p. 742). A narrow-pointed bistoury is advised. The most prominent part of the swelling should be deeply incised in a direction parallel to the meatal axis. Where post-aural œdema is pronounced a second incision in this region is desirable, and will frequently release pus ; the periosteum should not be divided. After-treatment as for the early case, omitting the manganese. If the condition tends to recur, save the pus for an autogenous vaccine.

Suppurative Lymphadenitis. The treatment of the most common variety, the post-aural, has been outlined above. If the furuncle affects the anterior part of the meatus, the lymph-glands involved will be those lying in the parotid region, deep to the parotid fascia. Direct external incision into this region should be avoided. The glands may usually be reached through an incision in the anterior wall of the meatus ; an aneurysm needle makes a convenient instrument.

CHAPTER XLIX

ACUTE SUPPURATIVE OTITIS MEDIA: ACUTE MASTOIDITIS

By ERIC WATSON-WILLIAMS, CH.M.

ALTHOUGH it is convenient clinically to discuss these as two separate conditions, there is no essential distinction. The mucous membrane of the middle-ear cleft is continuous, and within a few hours of onset of acute otitis the membrane of the antrum and mastoid cells has become inflamed. Whether this inflammation resolves or goes on to abscess formation and osteitis depends on the power of resistance, virulence of infection, and freedom of drainage; only the last factor can be materially affected by local treatment.

ACUTE SUPPURATIVE OTITIS MEDIA

Because the ear is not examined this condition is often overlooked in babies and in those prostrated by an acute specific fever.

Appearance of the Membrane.— Pus may lie behind a membrane that appears perfectly normal. But, as a rule, in the mildest cases the normal gloss of the membrane is lost and the light reflex with it; the colour is definitely pink, and from the region of the umbo and malleus small vessels may be seen radiating (*Fig.* 767, *a*); while there is definite

membrane. (The right tympanic membrane is shown in each case.) *b*, Acute otitis media, severe. The membrane is bulging and scarlet, and shows a haemorrhagic bulla in the posterior ...... Acute otitis media with bulging of the membrana flaccida. *d*, Herpes ...... be and just overlaps the malleus.

bulging outward, so that the malleus lies in a little fold. In a more severe case the whole membrane is bright red, and the bulging more pronounced, especially posteriorly (*Fig.* 767, *b*); in influenzal otitis crimson bullæ may form on the membrane and sometimes on the adjacent meatal wall; such bullæ may rupture (without perforation of the membrane), or may be partly absorbed, staining the membrane

for many weeks. Rarely the bulging may be confined to the pars flaccida, which then projects outward above the upper part of the pars tensa, partly obscuring it; the latter also, however, shows at least some reddening, evidence of general tympanic infection (*Fig. 767, c*). After perforation the injection and bulging of the membrane usually disappears.

Differential Diagnosis.— From :—

1. Furuncle of the meatus.

2. Herpes. A ruptured vesicle on the membrane looks very like a perforation (*Fig. 767, d*).

3. Dental disease. Remember unerupted molar.

4. Other conditions that may show severe earache, malaise, and fever, such as acute sphenoidal sinusitis (p. 701), lobar pneumonia, Vincent's angina, and meningitis.

MANAGEMENT OF ACUTE SUPPURATIVE OTITIS MEDIA

I. The Membrane is Intact.

The patient is given a full dose of calomel and ordered to bed. If the case is an early one and perforation has not occurred, instil into the meatus every four hours drops of glycerin with two per cent phenol warmed to 105° F. (40·5° C.). Apply dry heat to the ear by means of a hot-water bottle, electric pad, or bran bag ; avoid poultices, fomentations, and blisters, which tend to obscure the progress of the disease.

Paracentesis is indicated :

1. If pain or fever is conspicuous and not relieved within twenty-four hours, *even though the membrane appears normal*, or after one sleepless night.

2. If there is material bulging of the membrane.

3. If deafness is severe, especially in influenzal otitis.

4. If vertigo, nystagmus, or vomiting occurs.

My own practice is to advise immediate paracentesis in every case unless there is a definite contra-indication. The incision heals more rapidly and the hearing is less often damaged than after spontaneous perforation.

The Operation of Paracentesis Tympani : Myringotomy. —Brilliant illumination of the whole membrane is essential. Choose the largest speculum that will pass, and have ready aural dressing forceps. Test the edge and point of the myringotome. If the latter is not available a *fine* sharp-pointed tenotome may be used. In an emergency a long Hagedorn needle may be honed at the point to a double edge and the eye thrust into a small cork for a handle.

Anæsthetic. —Gas and oxygen is ideal ; gas alone will serve,

but bleeding is excessive. For small children ethyl chloride is suitable. Local anæsthetics are unsatisfactory.

TECHNIQUE. As soon as the patient is anæsthetized, disinfect the meatus with alcohol, and finally with a few drops of ether (to dissolve cerumen) which rapidly evaporates.

1. *The Pars Tensa is Inflamed* (*see Fig.* 767. *b*). The incision should start at a point midway between the umbo and the posterior wall, and sweep downward and slightly forward in a curve to end near the lowest point of the membrane (*Fig.* 768). One cut only can be watched, as blood and pus rapidly well up and obscure the field.

2. *The Bulging is Mainly of the Pars Flaccida* (*see Fig.* 767. *c*). — The same incision is made first. Bleeding is usually slight and there is time to carry out the next step; if not, blood is mopped out and the second incision made when the field is clear. This incision is made horizontally across the bulging part, not deeply, as that would imperil the malleus.

As a rule the incision is followed by brisk bleeding for some seconds. Mop out the blood and pus, again disinfect the ear, apply a strip (not a plug) of sterile gauze down the meatus, and a dressing to cover the ear. If adenoids are present and the surgeon possesses experience in their removal, this should now be done. Intense, but transient, vertigo with nystagmus and vomiting may follow the paracentesis.

Fig. 768. — Line of incision for paracentesis tympani. (Right ear.)

DIFFICULTIES AND DANGERS. —

1. Incising the posterior wall of the meatus instead of the membrane.

2. Starting the incision too high, risking dislocating the stapes.

3. Scratching the membrane; the knife should be felt to penetrate.

4. Forgetting the obliquity of the membrane, increased by the posterior bulging, and so 'cutting out' too soon; often unimportant, but the short incision may heal prematurely.

AFTER-TREATMENT. — Avoid syringing and all watery drops, particularly peroxide solution.

II. THE MEMBRANE HAS PERFORATED OR HAS BEEN INCISED.

Never syringe a running ear. It is possible to cleanse the meatus, or to disinfect the skin, by using drops. But the briefest consideration of the anatomy (*Fig.* 769) will show that no meatal applications will reach the bacteria in the mucosa of the mastoid cells; especially when (as usually) the perforation is a mere slit, and the air-spaces of the ear are filled with swollen mucosa and tenacious secretion. If water, hydrogen peroxide, or other irritants reach the tympanum they will often cause enough additional congestion to turn the scale

a   *c*   *b*   *d*
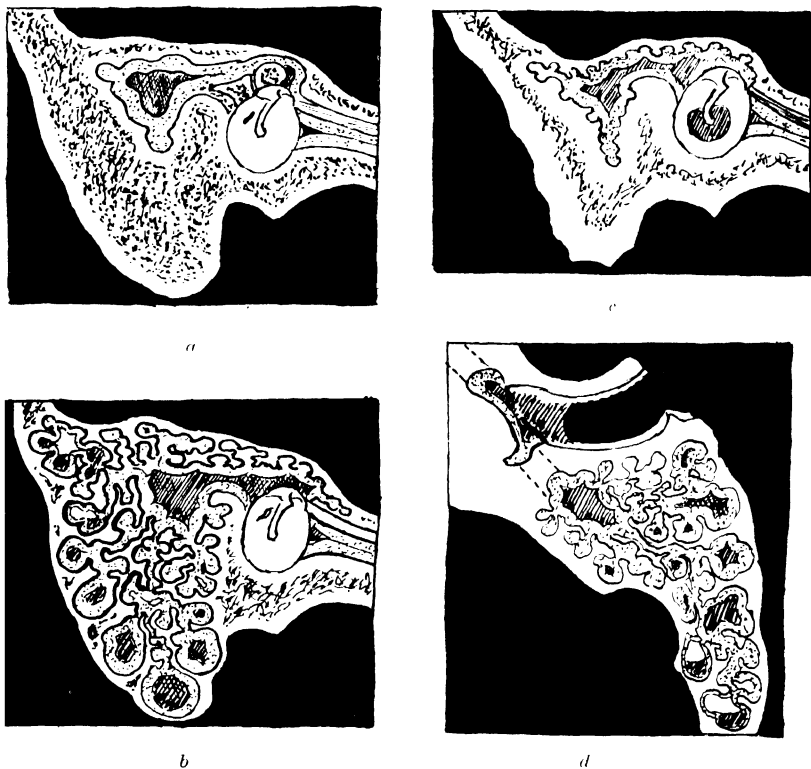
Fig. 769.

Fig. 769, *a.* Cancellous or infantile type of mastoid. Semidiagrammatic section in the (very oblique) plane of the tympanum. The tympanic membrane has been left *in situ* ; mucous membrane represented as swollen by inflammation, in fine dotted stipple ; discharge lying in the cells in heavy diagonal hatching. At birth there is no mastoid process, at one year old it has developed. The antrum is relatively large, there are no cells, the bulk of the process is composed of cancellous bone. This type persists in 5 per cent of adults.

Fig. 769, *b.* Similar section of cellular mastoid (75 per cent of adults). Incus and head of malleus removed. Cell development begins during the first year and is nearly complete by the tenth. The process is convex above and externally, the cortex thin, cancellous bone almost absent, and the bulk of the process is made up of a complex labyrinth of cells with thin walls, the peripheral tending to be larger than the central.

Fig. 769, *c.* Similar section of sclerotic acellular mastoid (20 per cent of adults). The process tends to be flat or concave, the external surface deeply grooved, the dura often dips downward external to the antrum. Antrum small, cells very poorly developed, cortex thick and dense, some cancellous bone. This type of mastoid is seldom seen when operating for primary acute mastoiditis, but forms the bulk of those met with in operating for chronic disease.

Fig. 769, *d.* Nearly horizontal section of same bone as in *b.* Position of aditus and Eustachian tube dotted. Shows the great obliquity of the middle ear cleft and tympanic membrane, and how far cells may extend around groove of sigmoid sinus.

(*From author's article in ' Modern Treatment in General Practice ', Vol. I.*)

against resolution. On the other hand, hygroscopic applications are of real value. The glycerin-phenol drops mentioned above may be continued (N.B. The B.P. preparation is too caustic); the best substance of all is finely powdered crystalline magnesium sulphate, with which the meatus may be filled. Before any application, cleanse the whole meatus by repeated mopping with fine pencils of dry wool.

Repeat the dressing as often as it becomes soiled; at first this may imply dressing every two or three hours. After one or at most two days the temperature should be normal, pain absent, and the discharge much less; if the discharge continues profuse, be on your guard—resolution that is slow to begin is often incomplete.

ACUTE MASTOIDITIS

Indications for Operation on the Mastoid.—The need for an operation to drain the mastoid may arise early, particularly in children; either before the membrane has perforated, or even when the ear condition appears to be improving. The indications for this operation are:—

1. *Pain or tenderness or fever persisting unrelieved forty-eight hours after the onset of discharge, or occurring as acute exacerbation in chronic suppurative otitis.*

2. Œdema lasting thus long, or great œdema at any time.

3. Signs of complications, or of toxic absorption.

4. *Severe* deafness (especially in influenzal otitis).

These are *alternatives*, any one of which may suffice: no case will present all. Tenderness is the least often absent. The œdema may occur: (*a*) In the post-aural sulcus, the commonest form (*Fig.* 770); (*b*) In the depth of the meatus, where it is easily overlooked; (*c*) Above or in front of the ear, i.e., 'temporal' or 'zygomatic'; (*d*) In the neck below the mastoid, often 10 cm. down or more—von Bezold's abscess.

Severe gastro-enteritis has been observed in infants in association with otitis media, which may have escaped notice. Only after mastoid drainage is the gastro-enteritis amenable to treatment.

Fig. 770.—Post-aural œdema.

A *skiagram* will show gross destruction of bone (*Fig.* 771), but is seldom helpful in the early stages in deciding whether operation is necessary, since from the very beginning the cell spaces are opaque. It will, however, show whether the mastoid process is cellular or

otherwise (*Fig.* 772): in the latter case especially a dense cortex may mask local signs of disease.
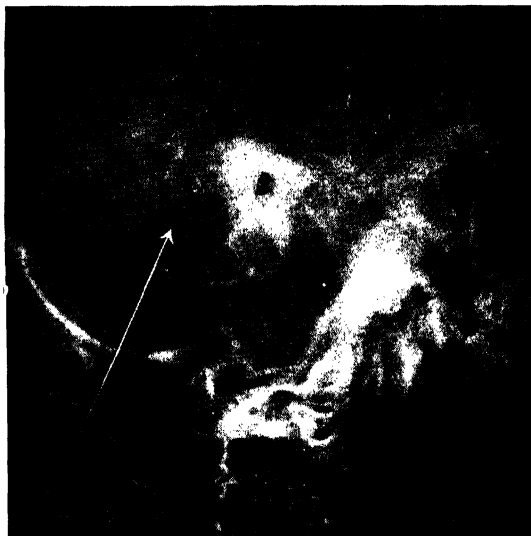
Fig. 771 — Skiagram

a   *b*

Fig. 772.—Skiagrams of (*a*) acellular, and (*b*) cellular mastoid.

When to Operate. The surgeon who has had experience of mastoiditis may decide to adopt a watching attitude, as long as the general condition is improving and there are no signs of complications. Expectant treatment has no place in the treatment of an acute exacerbation of chronic disease. If it is adopted, it is essential that the

patient should be under close observation, with specially trained nursing care, and next door to the operating theatre; and that, as soon as there is *any cessation in improvement* the operation should be performed. Those without extensive experience of these conditions should resort to operation as soon as one of the 'indications' appears. In a highly civilized country, however, the matter is seldom so urgent that the patient cannot be removed to a properly staffed and equipped centre.

Wilde's Operation. The indications for this operation are strictly limited. It is of value especially in children, and should only be entertained: (1) As a preliminary to removing the patient to a surgical centre; or (2) In a patient seriously ill from intercurrent disease, such as scarlatina, pneumonia, or nephritis. If following the incision symptoms abate within two or three days, further operation may be postponed or even avoided; otherwise a mastoidectomy should not be postponed, but the incision has done no harm.

ANÆSTHESIA. Gas and oxygen is suitable.

TECHNIQUE. The incision is made in the post-aural sulcus, 3 cm. long, down to and through the periosteum (*see* p. 748 as to incision in infants).

1. *Pus is Found.* Drainage is thus established, and the operation may be completed by the application of dressings.

2. *Pus is Not Found.* Take gouge and mallet, and remove a scale of the mastoid cortex in the centre, and along the line, of the incision.

Local Anæsthesia of the Mastoid Region. It is difficult to secure good anæsthesia of the bone and antrum, and in the presence of an extra-osseous abscess almost impossible. The method is unsuitable for children. It may be desirable in adults owing to a complication or to intercurrent disease, e.g., nephritis, diabetes, pneumonia. A full dose of morphine should be given half an hour before beginning. For the injection a solution of novocain hydrochloride (procain) 1 per cent, containing ten drops of adrenalin 1–1000 per 100 c.c., is suitable; for the meatus a stronger solution (4 per cent) is advised.

SCHEME OF INJECTIONS. –

1. The skin of the post-aural sulcus and that above, below, and behind it.

2. The deep fascia immediately below and behind the cartilaginous meatus (great auricular nerve) and that behind the upper part of the mastoid process (small occipital nerve).

3. The periosteum, including the margin of the meatus. Remember that the needle may enter an abscess, the mastoid emissary vein, or even the lateral sinus.

4. The depths of the meatus in its posterior half; considerab[ ]
pressure may be needed.

Wait ten minutes after completing the injections before beginning
to operate.

Mastoidectomy in Infants. In operating on infants one must
remember that the mastoid antrum is relatively higher than in the
adult, being indeed more above than behind the tympanic cavity.
The mastoid process is not developed, so that the facial nerve as it
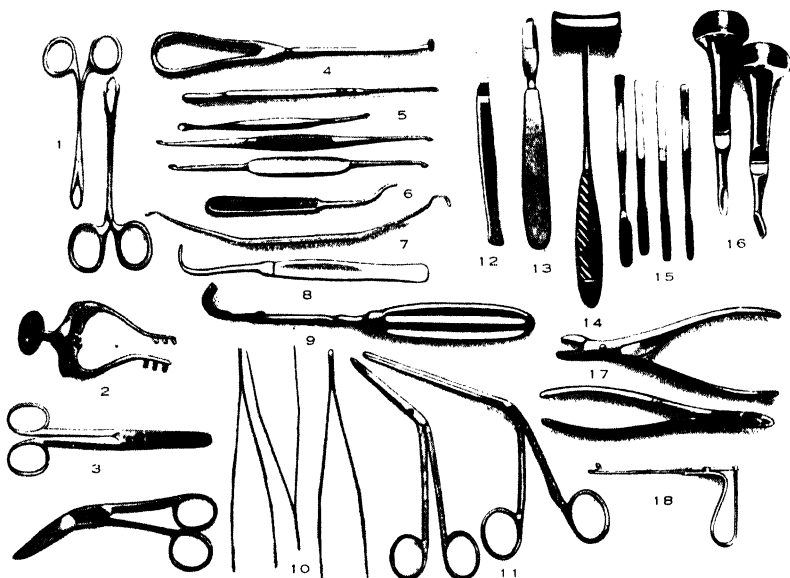
Fig. 773. Instruments for the Schwartze operation. 1, Two Lane's tissue
forceps; 2, Retractor; 3, Two pairs of scissors; 4, Retractor; 5, Four curettes;
6, Stäcke's guide; 7, Pus seeker; 8, Aneurysm needle; 9, Adenoid curette; 10,
Two toothed forceps and dissecting forceps; 11, Packing forceps; 12, Scalpel;
13, Periosteal elevator; 14, Mallet; 15, Four gouges; 16, Two hand gouges;
17, Two Jansen's bone gouge-forceps; 18, Granulation forceps. Needles, 6 towel
clips, and 12 haemostatic forceps are not shown.

emerges from the skull is liable to injury by an incision carried too
low. It is well in nurslings to limit the operation to what can be
done in fifteen minutes; in practised hands this suffices for a complete
operation; but the very young do not tolerate a long operation, and
it is better, once drainage of the antrum has been secured, to be
content if necessary with an incomplete operation, even though this
may entail subsequent further intervention.

Simple Mastoidectomy : Schwartze's Operation.—The operation of choice in all uncomplicated cases. The instruments required are shown in *Fig.* 773.

TECHNIQUE. The scalp in the immediate neighbourhood should be shaved to a distance of 5 cm. from the post-aural sulcus. If tenderness is extreme, this should be done after anæsthesia is complete. The surgeon wears a forehead lamp from which a beam of light is directed into the depths of the wound. The incision is curved down behind the ear, in or just behind the sulcus, to the tip of the mastoid process (*Fig.* 774. *a*). The periosteum is palpated to discover and avoid any dehiscence in the bone, divided, and reflected backward and forward so as to expose the posterior margin of the meatus, and the mastoid surface for about 3 cm. behind it ; the soft parts

a
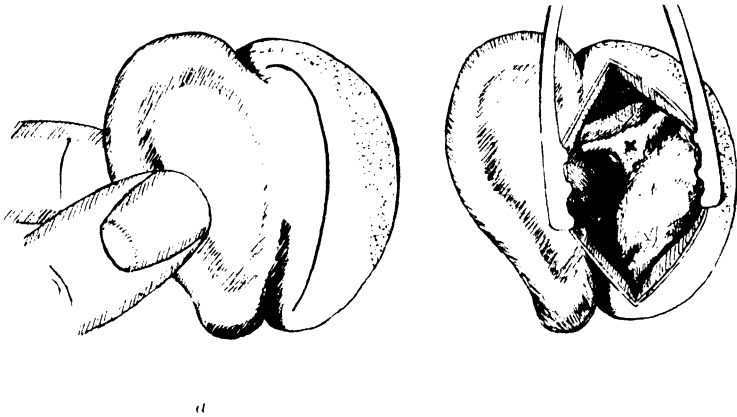
Fig. 774.—Schwartze's operation (I). *a*, Post-aural incision. *b*, Periosteum reflected and retractors inserted. The marking for the mastoid antrum is shown by a ✕.

are separated also from the bony meatus in the exposed region. In the upper part of the wound the temporal muscle should be pushed upward without division, while in the lower the attachment of the sternomastoid muscle should be reflected with the periosteum (*Fig.* 774. *b*). If an extra-osseous abscess is encountered the pus is mopped up ; considerable pulsation of the pus should put the operator on his guard for an extra-dural or peri-sinus abscess.

Before commencing removal of bone review the anatomy of the region ; the external configuration of the process often gives information as to cell development and distribution (*Fig.* 775. *and see Fig.* 769). Identify the bony margin of the meatus, with the spine of Henle, anteriorly. In the upper part of the wound clearly define the

supramastoid crest continuous with the superior root of the zygoma. The surface marking of the antrum is 1 cm. posterior to the highest point of the bony meatus. Just below this, in the living, may be seen a number of small bleeding points in the bone. It is here that the gouge should be applied in commencing the opening of the antrum.

In cutting through the hard cortex the aim should be to remove thin slices of bone by gentle taps with the mallet : the broad gouge should therefore be applied at the point mentioned very obliquely, and the stroke directed toward and into the meatus. The lateral sinus sometimes lies immediately beneath the bone surface, and may overlap the antrum posteriorly ; and in the acellular type of mastoid (see *Figs.* 769 *c,* 772 *a*) the dura of the middle fossa often dips down above it. Each stroke of the gouge should be controlled by careful
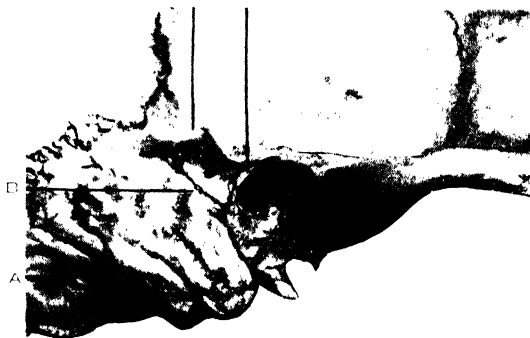
Fig. 775. — Schwartze's opera   (tH). Mastoid region. A hole has been drilled
outward from the centre of the au   m parallel to the axis of the external meatus ;
note that the centre of the antru   s on a level with the top of the meatus. The
small vascular foramina mentio   l in the text are visible.   A. Foramen for
mastoid emissary vein ;   B. Petro nastoid suture ;   C. Supramastoid crest ;   D.
Spine of Henle.   N.B. — The *right* mastoid is figured here, instead of the left
as elsewhere.

inspection, and if necessary by palpation with a pus-seeker. The bone may bleed freely and require constant mopping. By successive strokes of the gouge the bone is cut away to form a saucer-shaped cavity extending into the meatus (*Fig.* 776, *a*) ; a narrow deep hole makes the later steps difficult and dangerous. As soon as we encounter soft bone, granulations, pus, or mucous membrane, we lay aside the mallet and substitute the hand gouge to enlarge the opening. In the soft bone of the young, or when the disease has softened or perforated the cortex, this instrument may be used from the start — it affords a more easily and delicately controlled cut than the mallet.

When the antrum or other cavity is exposed, avoid contact of the gouge with the inner wall ; explore the dimensions of the cavity

with the pus-seeker, and enlarge the opening in the cortex backward or downward as appears necessary, so that the remaining steps are conducted under direct vision. All cells must be carefully followed up and opened, and diseased bone, granulations, and mucous membrane removed. Any point from which pus tends to well up must be meticulously investigated, removing bone until a full exposure is obtained *Fig.* 776, *b*). The post-facial group of cells is present even in the 'acellular' mastoid (*see Fig.* 769, *c*), after the second year. As the operation proceeds it is useful to flood the bone with hydrogen peroxide ; this blanches bone, removes clot, and shows up cancellous tissue and mucous membrane.

At times it is necessary to follow disease into the root of the zygoma or into a group of cells lying between the external semicircular
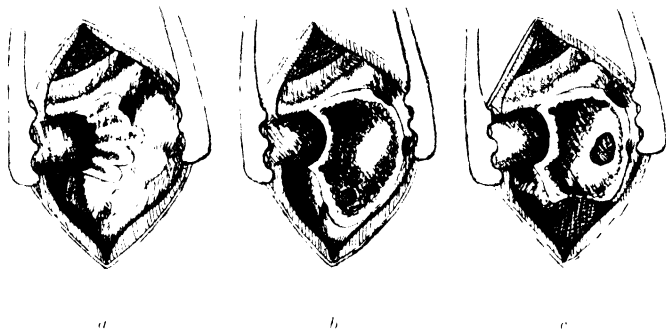
Fig. 776. Schwartze's operation (III). *a*, Removal of cortex begun. *b*, Removal of cortex completed. Most of the cells have been removed, and part of the dense wall of the sigmoid sinus has been cleared. *c*, Removal of bone completed. The whole tip of the mastoid has been removed, revealing the digastric muscle. The wall of the sigmoid groove has been further cleared, and has been opened to show the sinus itself.

canal and the middle fossa : be cautious in using the gouge or spoon in the aditus or over the torus of the external semicircular canal. If the tegmen is accidentally cracked, or seems not perfectly healthy, it is well to remove the affected bone ; no harm need be feared from exposure of the dura—it is tough and resists infection well. The approach to the sigmoid sinus is indicated by the discovery of a layer of dense bone ; it is advisable in all but early cases to remove a portion of this and to expose the sinus (*Fig.* 776, *c*). Often unsuspected pus lies in the groove (peri-sinus abscess, p. 758), and this should be sought if the covering bone looks 'dead-white' instead of faintly bluish. In either of these two last manœuvres the gouge should be used with care and tangentially ; and as soon as the dura is exposed a strip

of gauze should be packed in to protect it during removal of more bone.

Before completing the operation pass the pus-seeker *gently* into the aditus ; *if there is no aditus the antrum has not been opened*— it is probably higher up than has been thought. Cut down the posterior edge of the meatus to within 5 mm. of the tympanic membrane, and smooth off all bony ridges and points, so that the soft parts may fall in and help to obliterate the cavity. With a cellular mastoid the operation usually involves removal of the whole tip of the process (*Fig.* 776, *c*). Rub the bone surface with Bipp, lightly fill the cavity with iodoform gauze, and close the upper half of the incision with one or two points of suture, leaving the lower half open for drainage. Cover with a gauze dressing thickly spread with vaseline. In a child remove adenoids.

AFTER-TREATMENT.—As a rule the temperature falls promptly after operation, and other symptoms improve. Within three days the general condition should appear normal. If symptoms persist it may be a matter of no great moment, but be prepared to deal with complications—sinus thrombosis, labyrinthitis, etc. If toxæmia is severe general treatment may be supplemented by the intramuscular injection of 30 c.c. of antiscarlatinal serum ; this dose may be repeated.

If the case is progressing smoothly, the original dressing may remain 6 to 9 days. It is then removed, and a fresh strip inserted. As soon as granulations have shut off the tympanic cavity from the mastoid the wound may be allowed to close. The otorrhœa should have ceased by the tenth day ; treatment as suggested on pp. 743, 745 may be needed.

DIFFICULTIES AND DANGERS (*see also* pp. 755, 758).

Laceration of the Sigmoid Sinus.—This should rarely occur. The wound fills suddenly with venous blood that wells up freely. At once plug the cavity with a small gauze swab, maintaining finger pressure ; get ready a strip of ribbon gauze, remove the plug, and rapidly but firmly pack the ribbon into the tear in the sinus or into the hole in the covering bone if the latter is small. Uncover at least 2 cm. of the sinus, and at each end pack the groove in the bone, between the latter and the dura of the sinus, with iodoform gauze ribbon, until the lumen is obliterated. Remove the original strip to verify hæmostasis. The packing in the groove should remain four to six days.

The mastoid emissary vein may be torn across at its exit from the skull. The walls are continuous with the periosteum, and cannot retract or collapse. It is often possible to crush in the outer lip of the slit-like opening ; or the latter may be plugged with a small strip

of muscle or with Sir Victor Horsley's carbolized wax. Similar procedures are sometimes needed to cope with bleeding from other sources.

The Radical Mastoid Operation. —

INDICATIONS. In certain circumstances the simple mastoidectomy described above is inadequate, and the operation must be extended to the tympanum. This is necessary :—

1. When osteitis or cholesteatoma extends into the tympanum, and therefore as a general rule

2. In acute exacerbation of chronic suppuration where there is (*a*) aural polypus, (*b*) recent facial paralysis.

3. In tuberculous or 'cold' mastoiditis of infants.

4. As a preliminary to operation on the labyrinth.
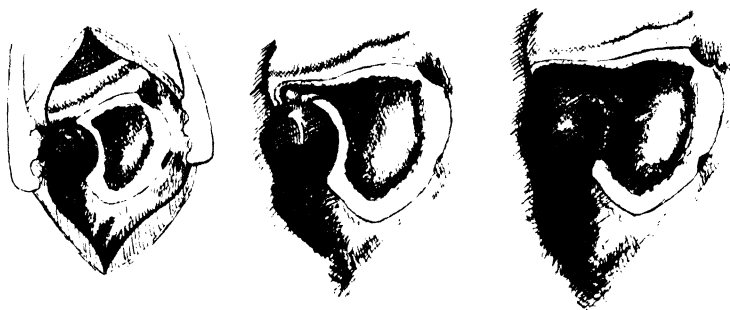
Fig. 777. The radical mastoid operation (I).

xtent of opera-

thi

panic space cut away, showing the head of the malleu
malleus and incus removed and the
ng the facial canal and the torus of the
stapes, the fenestra rotunda, and the opening of the Eustachian tube are indicated.
(*Note.* *b* and *c* are shown on a larger scale than *a*.)

In many of these conditions it may be possible to decide beforehand that the radical operation is necessary. The middle-ear tract is treated without regard to auditory function, as a septic sinus in bone, with the object of obtaining a single wide cavity ; subsequent useful hearing is unusual.

TECHNIQUE.—If the radical operation has been decided on from the start, the skin incision should follow the hair line, the flap of skin and deep fascia being reflected forward as far as the post-aural sulcus before the periosteum is divided at that level. Complete the simple mastoidectomy. Divide the skin at the bottom of the meatus close

to the tympanic membrane, exposing this at the bottom of the
wound (*Fig. 777, a*).   Verify the position of the aditus by again passing
the pus-seeker.   Now cut away the outer wall of the aditus and attic,
working from behind forward ; the hand gouge can be used, employing
the firm edge of the cortex as a fulcrum.   Work gently, avoiding
impact on the inner wall, and paring off the bone in thin slices.   To
attempt to remove large pieces is to invite splintering of the bone ;
this is the usual consequence of employing a blunt gouge.   There
is now no longer a bridge of bone separating the mastoid cavity from
the tympanic, but a hook of bone overhangs the lower part of the
aditus (*Fig. 777, b*).   Cut away this hook from above downward in the
same manner, and with the same precautions ; be especially careful
that the inner wall of the aditus is not used as a fulcrum for the gouge.

                   a   *b*   *c*
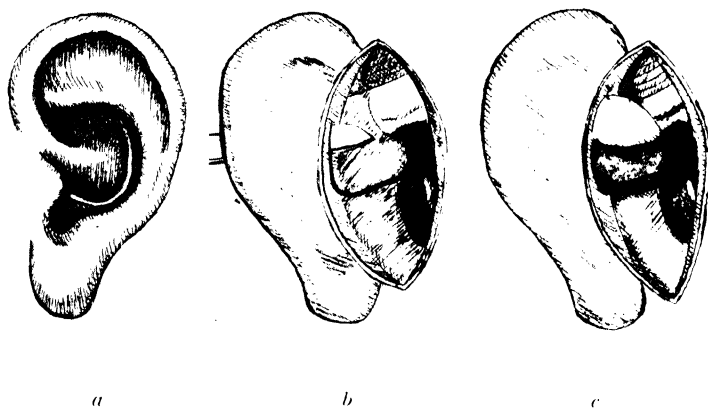
Fig. 778.- The radical mastoid operation (H).   *a*, Line of incision of the
concha.   *b*, Posterior view of the incision for enlarging the meatus.   *c*, The skin
stitched to the posterior aspect of the concha.

It is a good plan to ask the anæsthetist to watch the patient's face
while doing this ; the outer canthus and the angle of the mouth are
the parts to observe.   With forceps (e.g., granulation forceps) passed
from behind forward grasp and remove in turn the incus and the
malleus.   Make sure that the anterior part of the attic has been fully
uncovered so that there is no overhanging lip of bone.   With granu-
lation forceps, assisted by the curette very cautiously used, remove
any obvious granulations and the remains of the tympanic membrane.
Do not interfere with the region of the stapes postero-superior to the
promontory (*see Fig.* 783, 7), lest that ossicle be dislocated.   The surgeon
accustomed to operate on the mastoid will remove all mucous

membrane from the rest of the tympanic cavity and from the bony Eustachian tube.

Unless a complication is present the meatus should now be enlarged and the post-aural wound closed. Pass the knife down the external meatus, bringing the point out at the lower corner of the incision near the tympanic ring, and cut from within outward through the soft and cartilaginous meatus in a postero-inferior direction; watch that the point does not penetrate the sigmoid sinus. On reaching the external opening of the meatus turn the knife outward, and cut out and then upward, keeping just within the bowl of the concha (*Fig.* 778, *a*), the point of the knife passing up just within the post-aural incision (*Fig.* 778, *b*). There is thus defined a flap consisting of the bowl of the concha and the posterior wall of the meatus, attached only above; from the back of this remove the cartilage so that only the skin-flap remains. This skin-flap is now turned inward through the enlarged meatus and stitched up to the internal surface of the root of the pinna (*Fig.* 778, *c*); the inner free corner should be removed, as it becomes œdematous and hinders subsequent dressings. Close the post-aural incision, taking care to preserve the original level of the ear; complete the operation by packing the cavity lightly with iodoform gauze through the meatus and applying an external dressing of well-vaselined gauze. Skin-grafting is unsuitable for the acute case.

AFTER-TREATMENT. The ribbon gauze may be removed in 6 to 9 days, and the stitches at the latter period. For subsequent dressings ribbon gauze with 10 per cent ichthyol in glycerin may be used; and as soon as the post-aural wound is healed external dressings may be reduced to a piece of wool in the bowl of the concha. As healing proceeds it will suffice to clean the cavity daily and to insufflate this powder :

$$R \quad \text{Iodi} \qquad\qquad \text{gr. v (1 part)}$$
$$ \quad \text{Ac. Borici} \qquad \text{ad } \bar{3} \text{ j (99 parts)}$$
$$\text{In fine powder}$$

For at least a year some supervision will be needed lest collections of epithelium or of cerumen cause trouble.

DIFFICULTIES AND DANGERS : FACIAL PARALYSIS. We refer here only to facial paralysis of lower-neurone type.

1. *Occurring spontaneously*, in association with otitis media, in an infant this is highly suggestive of tubercle ; in an adult it is usually due to cholesteatoma. Operation is indicated.

2. *Occurring during operation*, facial paralysis may be due to crushing of the bone of the facial canal, or even to actual division of the nerve by careless instrumentation. In the former case, as

soon as sepsis is controlled (in about ten days) very cautiously cut away the damaged wall of the canal and cover the nerve with a graft of temporal muscle. In the latter nerve suture or anastomosis is necessary, but a description of the technique is beyond our present scope.

3. *Occurring after operation*, paralysis is usually due to infection via the iter chordæ posterius. Make sure that the packing is not too tight ; recovery is the rule. In rare instances paralysis indicates extension of infection to the labyrinth, or to the internal auditory meatus ; or it may be an early sign in pneumococcal meningitis.

In general, facial paralysis that comes on gradually, or some days after an operation, will be partial and transient ; that which occurs suddenly, during or soon after an operation, tends to be complete and (at least partly) permanent.

CHAPTER L

COMPLICATIONS OF MASTOIDITIS

By Eric Watson-Williams, Ch.M.

The more common complications of mastoiditis are acute nephritis, septicæmia, or pyæmia, extradural or peri-sinus abscess (*see below*), sinus thrombosis (p. 758), labyrinthitis (p. 761), meningitis (p. 767), and abscess of the brain (p. 770).

A rigor occurring in a patient with active ear disease is nearly always due to *sinus thrombosis*, and a second is practically pathognomonic (exclude malaria). Headache is not severe, neck rigidity is absent at first, and convulsions are not seen. *Suppurative labyrinthitis* begins as a rule abruptly with severe nausea, vomiting, and nystagmus; and symptoms tend to improve within two or three days. Attention may not be directed to the ear; remember that *a patient who is sick and giddy is nearly always sick because he is giddy* and not vice versa. *Meningitis* begins with severe headache, and usually vomiting; rarely with a rigor, sometimes with convulsions. Neck rigidity is usually definite from the start. Headache persists, and the condition gets much worse within a few hours or two days. *Brain abscess* begins insidiously as a rule; the early stage may be labelled 'influenza' or even disregarded. In the latter case the patient may be brought for advice only when drowsy, convulsed, or comatose. But sometimes an abscess may begin with a rigor, vomiting, or convulsions. Neck rigidity is not an early sign.

EXTRADURAL ABSCESS

This occurs in connection with cranial osteitis, and thus most frequently as a complication of mastoiditis. But it may be found in any region, e.g., in association with nasal sinusitis or with syphilitic necrosis of the vault. It presents no symptoms apart from those of the cause, except headache; but should be suspected if pain is not relieved by the usual operative procedures. It is often found unexpectedly during an operation in following up a track of infection in the bone; and may burrow under apparently healthy bone, giving rise to a 'puffy tumour' at some distance from the original focus. The barrier presented by the dura to internal extension of the suppuration eventually yields if treatment is delayed.

Treatment.—The whole thickness of the diseased bone must be removed completely with gouge and gouge-forceps. Where the

abscess extends under apparently healthy bone this also should be removed unless to do so would imperil important structures, e.g., the labyrinth. Free drainage must be maintained until suppuration is at an end.

Anterior Fossa.—The access to the dura adjacent to the nasal sinuses is discussed on p. 711.

Middle Fossa.—To expose the dura of the middle fossa the hand gouge should be used to pare off the tegmen antri in thin slices. As soon as the dura has been exposed a strip of gauze is packed in between dura and bone to preserve the former during further removal of bone. The exposure may extend over the whole middle-ear tract (*see* p. 751).

Posterior Fossa. The dura in front of the cerebellum may be exposed over an area between the sigmoid sinus and the internal auditory meatus, and between the lower part of the sigmoid sinus and the superior petrosal sinus running along the crest of the petrous. It is best to begin by exposing the descending limb of the sigmoid sinus (p. 751); pack gauze into the groove and remove bone internally, taking great care at the lip of the groove where dura and bone are adherent. In approaching the inner part, only a thin wedge of bone can be cut away, lest the posterior semi-circular canal be opened (*Fig.* 779).
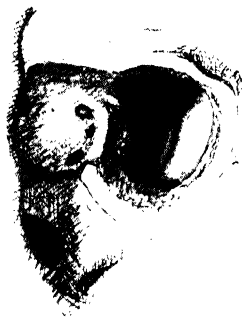
Fig. 779. Exposure of dura in front of cerebellum. (*See Fig.* 782 *a*, p. 764.)

Peri-sinus Abscess.—A common situation for an extradural abscess is in the groove of the sigmoid sinus itself, where it is named a peri-sinus abscess. Extend the uncovering of the sinus until a healthy part is reached at each end. The sinus wall may be covered with dense granulations; *gently* remove these with gauze and granulation forceps, and examine the sinus beneath. Do not explore the sinus with a needle; this may infect a healthy sinus, and even the recovery of fluid blood does not exclude the possibility of a mural thrombosis. If in doubt, treat as if the sinus is thrombosed.

THROMBOSIS OF THE SIGMOID SINUS

This may occur before the membrane has perforated.

Latent Stage.—A local thrombophlebitis is present, but the clot remains *in situ*. If no operation has been performed the signs are indistinguishable from those of acute mastoiditis (except that

headache may be present), and indicate operation, during which the condition of the sinus is discovered. If a mastoid operation has been performed the temperature remains unsteady, with a tendency to rise after a day or two; there is some deep pain, perhaps even tenderness; the wound looks healthy, and the general condition may continue satisfactory. The surgeon should consider whether perhaps thrombosis has occurred in a part of the sinus not examined at the operation.

Manifest Stage. The thrombus is breaking up and discharging showers of septic emboli into the general circulation. A rigor occurs, and is repeated with increasing frequency if the condition remains untreated. The general condition is less satisfactory. Signs of pulmonary infarction occur, and later, those of pyæmia. There may be stiffness of the neck, or even a palpable tender cord beneath the sternomastoid muscle (jugular periphlebitis). A rigor occurring in a patient with active otitis media is almost certainly due to sinus thrombosis (*but see* p. 757) and an indication for prompt inter-vention.

Queckenstedt's Test. This depends on the observation that when the jugular vein is obstructed the pressure of the cerebrospinal fluid is raised. A hollow plug is needed that will tightly fit the handle end of the lumbar-puncture needle; the barrel of a small-bore Record syringe will serve (e.g., an 'insulin' syringe). This is attached by a short length of rubber tube to a glass tube of about 3 mm. bore and 30 cm. long, and the whole sterilized. Lumbar puncture is per-formed with the patient on his side; as soon as the trocar is with-drawn the plug is fitted to the needle, holding the glass barrel vertically upward. The height to which the fluid rises measures the intrathecal pressure (normally not above 150 mm.). Mark this level with strapping. Now compress the jugular of one side, and then that of the other. If both sinuses are patent, the fluid level will rise 10-25 mm. whichever vein is compressed; but if, for example, the right sinus is thrombosed, pressure on the right vein produces no effect on the fluid level, while pressure on the left causes a marked rise (20 mm. or more). The test fails when only a mural thrombosis is present, but may be of great service when thrombosis is suspected in double otitis media.

Examination of the Sinus.—Uncover at least 2 cm. of the sinus as described on p. 751. The normal sinus has a tough wall, and shows the bluish colour of the contained blood; it is soft, com-pressible, and pulsating; the pulsation is more definitely appreciated by sight than by touch. The wall of the thrombosed sinus is thickened, and may be friable; the contents are black, though usually concealed

by the dirty grey, opaque wall; the sinus is felt as a firm cord, not compressible; communicated pulsation is better appreciated by touch than by sight. As long as the wall remains elastic, and there is no other evidence of thrombosis, the sinus may be left alone; it is amazing how long it can resist infection from a peri-sinus abscess. When genuinely in doubt, it is wiser to treat the sinus as thrombosed; and if a rigor has occurred this is imperative. Sometimes a sinus becomes obliterated at the site of thrombosis, and the part below is then empty but otherwise normal.

Treatment.—

1. *When a rigor has occurred*, expose the jugular vein in the neck (p. 527) and divide it between ligatures below the level of thrombosis. Bring the upper end to the surface of the wound, and insert a small strip of rubber dam alongside it, as periphlebitis is common. It may be difficult to find the vein; remember that the empty vein is a small, string-like structure which is apt to be retracted with the edge of the sternomastoid muscle. Proceed with the treatment of the sinus.

2. *When no rigor has occurred*, it is advisable to examine the sinus before exposing the vein. Remove bone until a healthy part is reached at either end; it may be necessary to go back a long way, removing bone as requisite; it is not advisable to uncover the sinus farther forward than the level of the facial nerve. At each end pack ribbon gauze into the sinus groove to obliterate the lumen of the sinus. Divide the sinus longitudinally with a sharp scalpel, being careful not to penetrate the farther wall. Insert a small sharp spoon and curette out the contents; even if fluid blood is present make sure there is no clot. Having removed the clot as completely as possible, take out the lower gauze plug, and see that blood flows freely. Replace the plug, using iodoform gauze ribbon, and repeat the procedure at the upper end. If there has been no rigor and the removal of clot appears complete, it is not necessary to ligate the jugular vein.

AFTER-TREATMENT.— The gauze strips may be removed on the third day; it is well, unless the patient is docile, to give nitrous oxide for this, though bleeding at this stage is very unusual.

P. C., age 13, came on March 28, 1928, complaining of pain in the left ear for four days, with deafness, following a cold; never any previous ear trouble. There was slight tenderness of the mastoid process, but no trace of swelling. The temperature was 102° F., and the tympanic membrane pink and bulging. Myringotomy produced blood only; next day the ear was discharging freely, but there was still some tenderness.

By the seventh day he was feeling quite well, and free from pain, though the ear was still discharging and the temperature had not quite settled (*Fig.* 780). That evening the temperature rose, and was 104° F.

at noon on April 5th. At this point it remained for three days. The boy was sleeping and eating well; there was no vomiting, no rigor; the only pain was slight frontal headache; there was no trace of mastoid œdema but on firm pressure the process was just tender.

A simple mastoidectomy showed a cellular bone much engorged, but free from pus except in one or two cells deep to the antrum, and a little purulent fluid in the apical cells. On opening the sinus groove a large offensive abscess was exposed, with the sinus lying in it thrombosed, perforated, and the thrombus breaking up. Treatment followed the lines indicated above; the jugular vein was not ligated. Convalescence was normal.
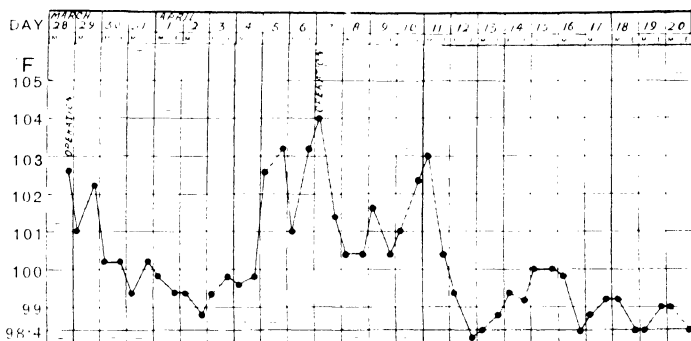
Fig. 780. Temperature chart of a case of sigmoid sinus thrombosis.

SUPPURATIVE LABYRINTHITIS

The severity of symptoms is proportional to the completeness and suddenness of the onset. In a characteristic case this is acute, with some pain in the ear and fever, which attract less attention than the intense vertigo and repeated vomiting. The vertigo is definitely a rotatory sensation. The patient lies in bed with the affected ear uppermost, maintaining the head in a definite position in space, that which he finds minimizes the vertigo. The least alteration of position renews the vertigo and vomiting, so that attempts to assist him to drink on the part of his friends who raise his head result in further vomiting; thus "he brings up everything as soon as he swallows it" and a wrong diagnosis of 'gastric influenza' is common. On the other hand, in young children, where the onset may be relatively insidious, and in those prostrated by illness, labyrinthitis may occur without attracting particular notice.

On examination the patient will be found to have mixed spontaneous nystagmus, the quick component of which is directed away from the affected side; this tends to be minimized on looking toward that side, to which the decubitus lends itself, so it may have to be specially sought. The following Table summarizes some points that distinguish labyrinthitis from cerebellar abscess :—

	CEREBELLAR ABSCESS	LABYRINTHITIS
Onset.. ..	Gradual, symptoms increasing in intensity during several days. Vertigo may be mild. Vomiting often late, sudden, related to headache rather than food, perhaps without nausea	Abrupt, with intense vertigo, vomiting, nystagmus. Symptoms tend to diminish in a day or two, but recur on movement. Vomiting related to movement, always with nausea
Nystagmus ..	Irregular, coarse, horizontal; quick component directed to side of disease, looking toward which makes nystagmus worse. On looking to opposite side a slight fine 'labyrinthine' nystagmus may be seen	Fine, regular, mixed rotatory and horizontal, quick component directed to healthy side, looking toward which makes it worse; lessened or abolished on looking toward diseased side.
Falling ..	Tends to fall toward the diseased *side*, no matter what the position of the head	Tends to fall in direction of diseased *ear*; thus, right ear diseased, head turned to right, falls backward; head turned to left, falls forward
Past-pointing*	The arm of the *diseased side only* deviates outward	*Both* arms tend to deviate toward the side of diseased ear
Ear	If deaf, deafness of 'ear' type. Tuning fork on mastoid heard better than on normal mastoid, on vertex heard better in diseased ear (if other healthy) Syringing ear with hot water (110 F.) may bring on labyrinthine nystagmus toward same side; with cold water, toward opposite side	Probably complete (nerve) deafness to all sounds. Tuning fork on vertex or mastoid heard only in opposite ear Syringing ear with either hot or cold water produces no effect at all

*The patient sits with eyes shut and arm extended forward, index finger touching fixed object; raises hand above head, then brings it down in attempt to touch object again.

To Test the Vestibule: Bárány's Caloric Test.

1. *When there is No Spontaneous Nystagmus.* Place the patient so that the head is tilted 60° backward, to bring the external semicircular canal into a vertical plane. Syringe the ear with cold normal saline (60° F. = 13° C.). If the vestibule is sensitive nystagmus directed toward the opposite side occurs. In a normal subject this takes place in one to one and a half minutes; with perforation of the membrane the time may be less; if no response is seen after five minutes' gentle syringing it is almost certain that the vestibule is 'dead'—be sure that the external meatus is not obstructed.

2. *When Spontaneous Nystagmus is Present.* Proceed in the same manner using water as hot as can be borne (107° F. = 42° C. or hotter). With a living labyrinth the spontaneous nystagmus is stopped and then reversed, i.e., directed *toward* the tested ear; if after five minutes there is no change in the nystagmus it is probable that the labyrinth is insensitive. It is wise, however, to assume that vertigo, vomiting, and nystagmus of recent appearance in a subject of otitis media are due to labyrinthitis or to cerebellar abscess.

Differential Diagnosis. From suppurative meningitis with purulent exudate involving the eighth nerve. If the symptoms resemble those outlined, but the labyrinth responds to the caloric test, and brain abscess appears improbable, this usually indicates *pressure on the stapes.* Causes:

1. Wax, i.e., keratosis obturans (p. 737).
2. Acute otitis without perforation (p. 742).
3. Chronic otitis media with cholesteatoma; a radical mastoid operation is needed (p. 753).

Management. — Suppurative labyrinthitis is a serious condition and often leads to meningitis or brain abscess. If the patient is seen within ten days of the onset of symptoms, the surgeon should undertake inferior vestibulotomy with as little delay as possible. After that interval, if the patient survives he passes into a condition of chronic labyrinthitis, symptoms gradually subsiding. No operative treatment is indicated, though for a month at least a careful watch must be kept for the onset of intracranial complications. In from six months to two years compensation is established; the ear is quite deaf and the vestibule insensitive. If for any reason a mastoid operation has to be performed, the vestibule should be drained at the same time; unless the surgeon is prepared to undertake this it is wiser not to operate at all.

INFERIOR VESTIBULOTOMY

Drainage of the labyrinth can be secured by the operation of inferior vestibulotomy. When in the course of a mastoid operation osteitis is found to extend into the labyrinthine part of the petrous bone, the semicircular canals will be opened in removing diseased bone, and inferior vestibulotomy completes the operation of double vestibulotomy; in other circumstances the inferior operation by itself will suffice. The special instrumentarium is shown in *Fig.* 781.

Stage 1. Complete the radical mastoid operation, omitting the plastic enlargement of the meatus (p. 753). Make sure that there is plenty of room and an adequate exposure of the inner wall of the tympanum. If necessary, to secure this, remove more bone posteriorly

and cut down the facial ridge to the limit of safety, i.e., until the hard bone of the facial canal is reached. Throughout this manœuvre the anæsthetist must watch the face. The stylomastoid artery runs immediately superficial to the nerve, usually in a separate canal of its own. In front of the facial canal and between it and the promontory will be seen three depressions from above downward : the niche of the oval window, with the stapes standing well up out of it, the sinus tympani, and the deeper recess of the round window near the lower part (*Figs.* 782, 783). From the geniculate ganglion the facial nerve runs back immediately above the first of these, then turns downward close behind them. The vestibule must therefore be opened below

Fig. 781.—-Instruments for vestibulotomy. 1, Burr ; 2, Two curettes ; 3, Pus seekers, fine and coarse ; 4, Two gouges ; 5, Two chisels ; 6, Mallet ; 7, Hand gouge. The mastoid instruments shown in *Fig.* 773 are required in addition to this set.

and in front of this part of the nerve. With the narrow labyrinth gouge directed inward, cut through the inner wall of the promontory from oval to round window (*Fig.* 782). The bone is thin, and very gentle taps only are needed. If force is used there is risk of damaging the base of the modiolus and opening the internal auditory meatus. Remove the thin scale of bone thus isolated, and lift the stapes from the oval window. In many cases pus will be found in the vestibule, but the cavity is small, and pus does not usually well up from it.

Stage 2.—Clearance of vestibule. In order to avoid post-operative vertigo it is desirable to remove the sensory parts of the vestibular cristæ. With curette and burr gently clear out the ampullæ, beginning with that of the external canal ; the instrument is passed through the

opening just made, backward and somewhat upward and outward. For the superior ampulla proceed upward and backward, slightly inward; for the posterior, backward, downward, and inward. The
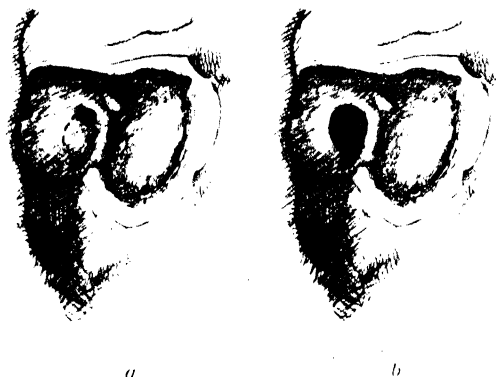
Fig. 782. Inferior vestibulotomy for labyrinthitis. *a*, The radical mastoid operation completed—the outlines of the foramina emphasized; *b*, The labyrinth opened. Cf. Fig. 783.
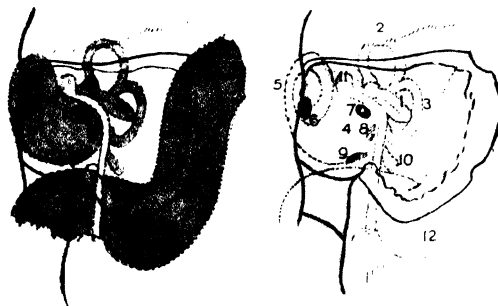
Fig. 783. The structures deep to the inner wall of the tympanic space, for comparison with Fig. 782. 1, External semicircular canal; 2, Superior semicircular canal; 3, Posterior semicircular canal; 4, Promontory; 5, Cochlea; 6, Eustachian tube; 7, Stapes in foramen ovale; 8, Sinus tympani; 9, Fossa of foramen rotundum; 10, Saccus endolymphaticus; 11, Geniculate ganglion and facial nerve; 12, Sigmoid sinus.

inner wall of the vestibule should be gently cleared next, paying special attention to the recessus sphericus, which lodges the saccule and lies rather forward of the oval window. Dress the bone with

Bipp ; insert a drainage tube down to the opening, securing it in
position with iodoform ribbon, and apply external dressings ; do not
suture the posterior wound.

After-treatment.— The dressings should be changed on the third
day at least.   If the operation has been complete there is no vertigo
while at rest in any position, and little during movement.   A fine
nystagmus to the opposite side persists for some weeks, and there
may be ataxia when walking is first attempted.   Definite post-operative
vertigo shows that the removal of the cristæ has not been complete.
It is best treated by keeping the patient completely at rest in the
position of greatest comfort, providing a feeding cup with a flexible
tube so that he can feed without moving the head.   Quinine and
hydrobromic acid may be given :–

> R   Quinin. Hydrobrom.   gr.ss (grm. 0·03)
>   Ac. Hydrobrom. Dil.   ʒss   (2 c.c.)
>   Q.q.h., ex aq.

Some facial paresis frequently follows this operation.   It is usually
transient.   Facial paralysis with fever, headache, and neck rigidity
suggests the onset of Politzer's abscess (p. 767).

CHAPTER LI

INTRACRANIAL SUPPURATION

By Eric Watson-Williams, Ch.M.

SUPPURATIVE MENINGITIS

This begins as a *local* process, and in certain cases the spread may be relatively slow. The patient is anxious, worried, and irritable ; but the mental state may be clear, and he may walk about and even transact business for two or three days after the onset. Headache is constant, with irregular exacerbations of great severity (headache is seldom *conspicuous* in uncomplicated otitis). When the base or posterior fossa is involved rigidity of the neck is an early symptom (*see* p. 757). Head retraction, coma, incontinence, and paralyses or changes in the deep reflexes indicate a *late* stage of meningitis.

Two conditions may occur complicating labyrinthitis which owing to their bearing on treatment demand special notice : (1) *Abscess of the internal auditory meatus* (Politzer's abscess). Dull pain is felt deep in or behind the ear, and facial paralysis is present. (2) *Meningitis of the cisterna pontis*. The cerebrospinal fluid may be clear or only faintly opalescent. The signs of these conditions are those of meningitis of the posterior fossa ; fever is not conspicuous ; the mental state is often dull.

Lumbar puncture is of value in diagnosis, treatment, and prognosis. In the table overleaf are listed the characteristics of the cerebrospinal fluid which are of diagnostic significance.

Differential Diagnosis. From other forms of meningitis, encephalitis, brain abscess, influenza, endocarditis, typhoid, typhus, yellow fever, tick fever. Remember that haemorrhage in the posterior fossa may produce fever, head retraction, headache, and permanent changes in the labyrinthine reflexes (*see* p. 762).

Treatment. Signs of meningitis are an urgent indication for prompt and vigorous operative treatment ; a patient may recover even if comatose, incontinent, and with purulent C.S.F. containing living streptococci. The only factor that the surgeon can influence is the time spent between diagnosis and operation. Do not wait for expert reports on the lumbar-puncture fluid if this means delay even for a few hours. To illustrate the extreme importance of early treatment, in a personal series of 23 consecutive cases of spontaneous suppurative meningitis, in 7 treatment was given within three days

DIAGNOSTIC CHARACTERISTICS OF THE CEREBROSPINAL FLUID

SEPTIC MENINGITIS

Pressure (see p. 759)	100–150 mm. fluid not more than two drops per second from the needle	Definitely increased, ...creased	Much increased
Appearance ..	Perfectly clear*	Opalescent or turbid†	Usually clear or faintly opalescent
	0–4 per c.mm., all lymphocytes	Over 100, usually over 500 per c.mm.; 50–90	found ; typically 10–30 per c.mm. of which 10–30 per cent polymorphs
Bacteria	None	May be numerous and sometimes grow on culture	Usually absent
Glucose	0·045–0·8 per cent	Diminished or absent	Normal or slight increase§
Chloride		Diminished : under 0·6 probably tuberculous	Normal

* Clear or faintest opalescence, with cobweb coagulum on standing ; probably tuberculous meningitis.
† (a) 500 lymphocytes per c.mm. may give only faintest opalescence ; 200 polymorphs usually impart definite turbidity. (b) ' Leaking ' brain abscess shows turbid fluid, with many polymorph cells, and perhaps bacteria, diminished glucose, normal chloride.
‡ Also in meningococcal meningitis. § Also in encephalitis lethargica.

of the onset—all recovered ; among 16 treated after the third day only four recovered.

Method of Treatment.—This must comprise thorough eradication of the infective focus—mastoid, labyrinth, nasal sinus, etc., and exposure of the dura over the whole accessible area adjacent (*see* pp. 711, 758). A careful search may be needed to reveal the primary focus ; sphenoidal sinusitis is the most likely to be overlooked—in a series of 19 deaths from 'unexplained' suppurative meningitis 16 were due to this cause.

Lumbar Puncture should be repeated at least daily, in a severe case twice daily at first, until meningitic symptoms have disappeared and the fluid is 'normal'. At the first puncture do not take off more than 20 c.c. ; later, withdraw enough fluid to reduce the pressure to normal (*see* Table *above*).

Medication.—The introduction of disinfectants directly into the theca is more likely to hinder than to help the natural defences, and

carries definite risk of permanent injury. There is less objection to the introduction of 3 c.c. of concentrated antistreptococcal serum, but there is not yet enough evidence to show whether it is of value. Every day, before performing the lumbar puncture, give 50 c.c. of colloidal silver (e.g., collosol argentum) by the intravenous route. Intramuscular injection of serum seems at least as useful as intrathecal. (For headache, *see* p. 779.)

Drainage of the Internal Auditory Meatus. — This procedure is indicated : (1) When meningitis follows labyrinthitis, the cerebrospinal fluid is purulent, and the general condition grave and not improved by vestibulotomy ; and (2) For abscess of the internal auditory meatus.

Perform inferior vestibulotomy (p. 763). The internal meatus lies immediately internal and very slightly anterior to the oval window. Into the upper part of the opening into the vestibule, corresponding to this window, pass the narrow labyrinth gouge directly inward so that the edge rests on the base of the modiolus. Taking care that the gouge shall not penetrate deeply, with a sharp tap of the mallet cut through the base of the modiolus : if the first attempt is unsuccessful repeat the manœuvre with the gouge 1 mm. farther forward. The cisterna pontis sends out a prolongation into the internal meatus, and opening is indicated by a free flow of cerebrospinal fluid. Complete the operation as for vestibulotomy. The flow of fluid from the opening may cease after a few hours ; if symptoms recur, pass a fine curette (not farther in than 1·5 cm. beyond the inner wall of the tympanum) and curette the passage to re-establish drainage.

A woman of 55, the subject of old-standing otitis media, was brought to me with manifest meningitis. She had had severe headache, frontal and temporal, for one week, with shivering attacks the previous night. There was no vomiting, and she said she had not been giddy. Head retraction was definite, Kernig's sign doubtful, knee-jerks increased, temperature 101·4 F. She was slow in answering questions, confused, drowsy, and groaning with pain. No earache, but tenderness over the left mastoid antrum, and mixed spontaneous nystagmus to the right : labyrinth irresponsive to tests. Lumbar puncture yielded opalescent fluid under great pressure : the fluid contained many pus cells and no sugar. After the puncture she said that she had been giddy for several days with a tendency to fall to the left.

At operation a very large cholesteatomatous mass was found occupying and expanding the antrum and aditus ; the facial nerve ran through it, devoid of any support. The stapes was absent, and the oval window exuded pus. The whole labyrinth capsule was carious, and was removed with its contents : the posterior cranial fossa was opened through the internal meatus. A good gush of cerebrospinal fluid was obtained.

The patient was very restless all night and noisy : next day there was no pain, no vertigo, no nystagmus ; cerebrospinal fluid was draining well and the temperature was normal. On the third day the flow of fluid

ceased, and there was some delirium with fever and signs of meningitis; the opening was curetted, re-establishing the flow of fluid. From that point she did not look back. Nine years later she is in very good health, and a genuinely grateful patient, though the facial paralysis is of course permanent.

ABSCESS OF THE BRAIN

A brain abscess may result: (1) From penetrating wounds, sometimes many months after the injury, the position of which may give a clue to that of the abscess. (2) Metastatic abscess is seen in association with lung suppuration, bronchiectasis, empyema, etc., rarely with suppuration elsewhere, osteomyelitis, furuncle, even quinsy or dental sepsis; multiple abscesses with pyæmia, or ulcerative endocarditis; such an abscess may occur in any part of the brain, and location may be a neurological problem. (3) With disease of nasal sinuses or ear.

The last is by far the most frequent source, and will alone be considered fully; the technical details of approach to other sites can be devised by suitably modifying the scheme described below.

The symptoms of the earlier stages are often vague and puzzling (*see* p. 757). The classical signs are those of a *late* stage; headache, vomiting, drowsiness, delirium, convulsions, papillœdema, slow pulse, constipation, rapid wasting. These are evidence of *compression of the brain*, and in every case where it is possible treatment should be afforded before they appear. Signs both general and localizing are due to œdema, not as a rule to increase in the actual abscess itself. They thus tend to be at first intermittent, and may be missed unless the closest watch is maintained; in a suspected case have pulse and temperature recorded every half hour. Some of the features of a typical case of subacute temporo-sphenoidal abscess are indicated on the chart (*Fig.* 784). The march of events may be much more rapid in the less common acute type, or with suppurative encephalitis, which is a cellulitis rather than an abscess.

Diagnosis.- As has been indicated, early diagnosis may be difficult. The condition may be suspected where without very definite signs there is complaint of chilliness, nausea, greater malaise than would be expected, or rapid wasting. The discovery of aural or other suppuration may provide the key.

Differential Diagnosis. -Tuberculous meningitis or encephalitis lethargica may be simulated. If the patient is comatose, consider concussion, hæmorrhage, uræmia, diabetes, alcohol, and drugs. Other conditions to exclude are cerebral gumma or tumour, and those mentioned on p. 767.

Management.—At any moment the abscess may burst into the subdural meningeal space or into the ventricle (hyperpyrexia, etc.);

or death may occur from coma or respiratory failure. The surgeon must be ready to be his own neurologist, and to explore the brain on a reasonable suspicion, without waiting for characteristic signs.
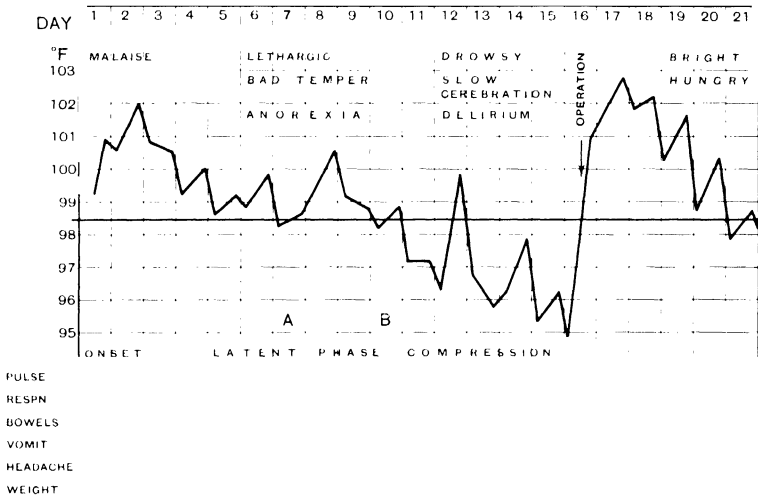
Fig. 784. Temperat chart in case of subacute temporo-sphenoidal absce A, Pulse 56 for one hot n morning; B. Temp. 95·4 at 2 p.m.; E. Enem N. Nausea; V. Vomit.

Lumbar Puncture. It cannot be too often repeated that there is definite risk in performing lumbar puncture when a brain abscess (especially a cerebellar abscess) is present. If necessary for diagnosis, postpone it until the patient is in the theatre, and ready for immediate operation, and withdraw only 2 c.c. (*See* p. 768.)

Location of Abscess. The best guide is the discovery of an adjacent lesion, e.g., in one ear; the abscess is seldom more than 1·5 cm. from the nearest surface of such lesion. Difficulty may occur when more than one such is present, for example, bilateral otitis media.

In the *frontal lobe* an abscess seldom produces symptoms which locate it; euphoria may be present.

In the *temporo-sphenoidal lobe* an abscess is twice as frequent as in the cerebellum; it is often 'silent'; signs occur in the face and limbs of the *opposite side*—paresis, spasticity, Babinski's sign, sometimes Jacksonian fits; there may be defects of both visual fields, or if the left brain is involved difficulty in remembering the names of common objects.

In the *cerebellum* an abscess usually follows sinus thrombosis or labyrinthitis; there are generally *some typical signs in the limbs of the*

affected side, ataxia, inco-ordination, weakness, as well as vertigo, nystagmus, etc. (p. 762); fits may recur, and tend to bend the body toward the affected side. A skiagram very seldom shows a brain abscess; ventriculography is not suitable in acute abscess.

TREATMENT

Should one treat the abscess alone, or the primary lesion as well? In dealing with a metastatic abscess, or in otogenous abscess when the patient is gravely ill, treat the abscess. In abscess secondary to frontal or ethmoidal disease it is almost necessary to deal with that *en route;* and in all ordinary cases of otogenous abscess treat the ear first and continue the operation to deal with the brain. At times the ear operation will show an area of disease of the dura indicating the best place to explore the brain, through a region where there are already adhesions between it and the dura.

ANÆSTHESIA.—A comatose patient may allow the surgeon to operate with local anæsthesia or even with none at all. In most cases a general anæsthetic is needed; many surgeons prefer chloroform to ether.

Fig. 785. Cannula and (P. Watson-Williams's sphe complete, with drainage tube bore.

INSTRUMENTS.— The instruments for the mastoid operation are shown on p. 748; add skull-cutting forceps, epicranial hæmostatic forceps (e.g., Sir Percy Sargent's) if available, and a 2·5 cm. trephine. On a separate table have ready a spare sterile towel; toothed dissecting forceps; scalpel; scissors; four pairs of light hæmostats (Cushing's silver clip hæmostatic set if available); blunt grooved director; sinus forceps or Horsley's brain pus-seeker; 5-c.c. syringe fitting cannula; cannula of about 2 mm. bore and 12 cm. long, preferably graduated in centimetres, with a *blunt* obturator (if the special form shown in *Fig.* 785 is not available, a straight suprapubic or liver abscess cannula may be got ready by rounding off the point of the trochar, if sharp, with a file); drainage tube which just fits easily over cannula; small curved needles and fine silk or catgut.

The Operation. —

The whole side of the head should be shaved up to the middle line. Complete the mastoid operation, omitting for the time any operation on the cartilaginous meatus. Proceed to uncover the dura of the middle or posterior fossa as the case may be; if the situation of the abscess is not determined examine the dura covering the temporo-sphenoidal lobe first, unless lateral sinus thrombosis or labyrinthitis is present, when the chance of the abscess being in the cerebellum is much enhanced. The exposure should be free; in the middle fossa the roof of the tympanum and mastoid should be removed in the manner described for extradural abscess (p. 758); in the posterior fossa the exposure extends in front of the cerebellum as shown on p. 758 (*Fig.* 779). Carefully examine the dura to discover any area of softening; rarely an actual sinus exuding pus is seen leading right through the dura.

Obvious Disease of the Dura is Found. Clean the whole wound by flooding it repeatedly with hydrogen peroxide solution, dry it, and swab the surface freely with liquor iodi. With a scalpel puncture the centre of the diseased area, and enter sinus forceps through the wound, or through the sinus if present, in either case keeping the forceps perpendicular to the surface of the dura, or as nearly as this is possible. Do not penetrate beyond 1·5 cm. Open the forceps, and if pus is found, without withdrawing them insert a drainage tube into the abscess, securing it by a stitch to the dura. The tube should not have lateral holes, which become blocked with brain tissue and tear the latter on removal; it should project well down into the wound away from the dura itself. The after-treatment is discussed on p. 779. If pus is not encountered at once, do not attempt further exploration through the limited area exposed, but proceed as below.

No Obvious Disease of the Dura is Found. —This is usual. Clean the cavity as above and proceed to the wider exposure necessary for systematic exploration of the brain. Unless there is reason to suspect cerebellar abscess, explore the temporo-sphenoidal lobe first.

Exploration of the Temporo-sphenoidal Lobe.—

Incision. —An incision is made starting at or a little in front of the stephanion and running along the line of the lower temporal ridge, back and then down to a point about 2 to 3 cm. behind the upper part of the post-aural sulcus, then forward to this and down to the tip of the mastoid process ; the line of the upper part of the incision is shown in *Fig.* 488, p. 484. The incision is deepened until the bone is encountered, and the pericranium is reflected; the edges thus turned up are secured with epicranial hæmostatic forceps ; if these are not available, the

numerous bleeding points are picked up as the incision is made, otherwise bleeding is free and may be troublesome. The temporal muscle is reflected with the skin flap and external ear to afford a free exposure of the squama and adjacent bone (*see Fig.* 787); inadequate exposure adds unnecessarily to the already sufficient difficulties.

Removal of Bone.- If no mastoid operation has been done a trephine may be employed, and some prefer this in any case. Apply the trephine so that the lower edge is just above the centre of the supramastoid crest (*Fig.* 786). Having removed the disc of bone, press the dura away from the margins with gauze, and proceed to

Fig. 786. Sk   show positions for trephining (A) for temporo-sphenoidal
abscess. (B) for ce   abscess. The broken line shows the trephine position, the
dotted line the ar   one removed. The solid line indicates the position of the
lateral sinus (tha   right side is larger). The shaded area shows the bone
usually removed i   astoid operation.

enlarge the opening in all directions with gouge forceps until it measures at least 4 cm. along the crest and 3 cm. vertically (*Fig.* 787). See that the edges are smooth, especially at the lower corners. If a mastoid operation has been performed the removal of bone extends into the opening in the tegmen described above. I myself, in common with many operators, prefer to expose the dura by paring away the bone of the supramastoid crest in a tangential manner with mallet and gouge, enlarging the small opening exactly as if it had been made with a trephine. In the upper part of the opening the posterior branch of the middle meningeal artery will be discovered as the squama is removed.

Exposure of Brain.—The dura tends to bulge into the wound. Carefully clean it with spirit or liquor iodi. Change the gloves for a clean pair, discard all used instruments, and bring the special clean set into use. Take the clean sterile towel, cut in it a hole of about the same size as that in the bone (the hole always stretches), and cover the whole operative field except the exposed dura. Pick up the latter with toothed forceps in the centre of the line joining the superior root of the zygoma to the remains (posteriorly) of the supra-mastoid crest ; one is tempted to select a point too high up. With a clean scalpel make a small nick, introduce the grooved director immediately beneath the dura and divide this backward and forward
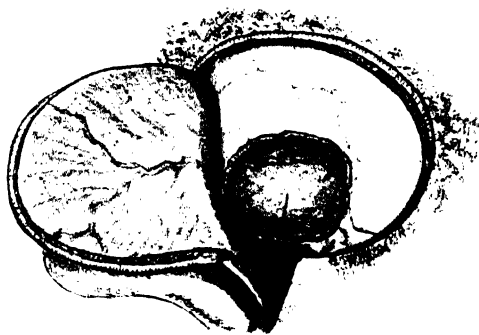
Fig. 787.—Exposure of dura for temporo-sphenoidal abscess (on same scale as *Fig.* 786). The lines of incision in the dura are indicated.

for a total of 2 cm. This procedure is adopted to avoid wounding the large vessels of the pia mater which are pressed close against the dura ; if this accident unfortunately occurs, complete the dural incisions, and pick up the wounded vessel with great care in hæmostatic forceps. As a rule forceps pressure for five minutes will control bleeding ; do not try to twist off the forceps or to tie off the vessel—if pressure alone fails, and the special silver clips are not available, it is better to run a fine catgut suture under the bleeding-point.

In a similar manner make a vertical cut transforming the linear into a cruciform incision (*see Fig.* 787) : if the tegmen, etc., has not been removed the downward part of this cut cannot be made and an inverted T incision must suffice. The brain bulges strongly into the opening in the dura ; this helps to shut off the arachnoid space at the edges. The protruding brain appears at first not to pulsate, but the pulsation can be readily felt, and is usually soon visible.

Exploration of Brain. Cut off 6 cm. of drainage tube and slip it over the cannula, passing it up to the handle end. Select a point in the brain free from large vessels just beneath that at which the dura was picked up. Pass the cannula with its obturator directly inward for a distance of 2 cm., keeping parallel to the inferior surface of the brain and as nearly as possible 1·5 cm. from it (*Fig.* 788). Remove the obturator; if no pus flows attach the syringe and *gently* aspirate. If there is still no flow, replace the obturator, advance the point half a centimetre or slightly more, and repeat the manœuvre. It is safe to explore to a total depth of 4·5 cm. from the external surface of the brain. About five 'steps' are needed to reach this depth. Do not let the cannula pass upward for fear of entering the ventricle.

Fig. 788. Temporo-sphenoidal abscess. The dura has been incised, and the cannula is being employed in exploration of the brain. (⅔ *natural size.*)

If the abscess is still not located, enlarge the dural incision (using the grooved director) forward for 2 cm. and repeat the whole process; some surgeons prefer to make a new incision in the dura for this. If still unsuccessful make another exploration 2 cm. behind the first. In this way we explore the brain at 15 points over an area of 4 cm. 4·5 cm. at a distance of 1·5 cm. from the lower surface, which should suffice to locate most abscesses. The entry into an abscess cavity can often be distinctly felt; if there is a feeling of resistance, and the abscess is not entered, a sinus forceps or Horsley's pus seeker may be used, but these damage the brain much more than the cannula. Unless there is good reason to suspect an abscess unusually far forward or back do not make further punctures; if such exploration is performed, remember the downward slope of the middle fossa and lateral ventricle forward.

Drainage of Abscess : Pus is Encountered. An abscess once 'lost' may never be 'found' again. Do not allow the cannula to move at all ; slip the drainage tube down the shaft until its end is level with the tip (on a graduated cannula with 6 cm. of drainage tube the top must be at the 6 cm. mark). Fix the tube by two stitches to the dura ; now, but not before, remove the cannula. Pus may well up through the tube ; receive it on gauze to save the brain as far as possible. The end of the tube should project at least 1 cm. outside the dura ; if any is cut off, note how much for future guidance. Dress

the brain surface with strips of gauze soaked in glycerin—no other chemical should be allowed to come in contact with it. This supports the brain and steadies the tube. Do not attempt to close the dura. Close the incision in the scalp as far as possible, using two 'tension stitches' to bring the temporal muscle up ; the posterior part of the incision is not closed, in order to allow for dressings. A very large external dressing is advisable.

Pus is Not Found. The abscess may be in the cerebellum ; proceed to explore this forthwith.

Exploration of the Cerebellum.

Incision. An incision is made down to bone in the post-aural sulcus, and prolonged down to the tip of the mastoid process ; from near the upper end of this a second incision is carried back along the superior curved line, and at the external occipital protuberance is curved down-ward for 3 cm. (*Fig.* 789). The edges are reflected, and bleeding controlled as described above (p. 773). The muscles are separated from the back of the mastoid process and from the occipital bone ; bleeding may be troublesome, and is best avoided by keeping the rugine close to the bone surface.

Fig. 789.   Incision for cerebellar abscess.

Removal of Bone. If a trephine is used it should be applied so that the upper edge lies on the superior curved line and the anterior edge 4 cm. behind the posterior margin of the external meatus (*see Fig.* 786). Remove the disc of bone, and enlarge the opening forward and upward until the horizontal part of the lateral sinus and the descending limb of the sigmoid part have been exposed, taking care when the groove of the sinus is reached not to wound the vessel. If a mastoid operation has been performed the exposure may be carried out in the reverse order, working backward from the place where the sinus is exposed in the mastoid. In either case the hole in the bone needs to be 3 cm. down and 4 cm. back from the mid-line of the lateral sinus.

Exposure of Cerebellum. Change gloves and take clean instruments ; cover the field with the clean towel with a hole just corresponding to that in the bone. With the toothed forceps, pick up the dura a short distance behind and below the curve of the sinus and open it by making a nick with the scalpel. Extend the opening both back and down (to make an ⌐), cutting on the grooved director. A small

triangle of cerebellum is exposed. Only rarely can the site of the abscess be determined from an abnormal appearance of the surface ; if such is seen, of course explore first the affected lobule. A cerebellar abscess begins as a narrow slit in the axis of the white matter of one lobule.

Exploration of Cerebellum.— Use the cannula and blunt obturator as described above for exploring the cerebrum. Enter it near the anterior part of the exposed area, and direct it at first inward and definitely forward toward the internal auditory meatus. At first enter only 1 cm. ; and progress in successive steps to a total depth of 4·5 cm. If no abscess is encountered, explore directly inward through the same puncture. If still unsuccessful, make a fresh puncture 1·5 cm. lower down, and repeat the explorations. The cerebellum may be further explored by opening the dura *in front* of the sigmoid sinus (p. 758), and exploring inward and backward for not more than 2 cm. from the surface ; it is difficult to arrange drainage here, and if an abscess is found it should be drained by passing the sinus forceps (armed with drainage tube in the same way as the cannula) from behind the sinus until the tips of the two instruments meet, and providing drainage via the posterior route. The passage and securing of the drainage tube, dressing the brain, and closure of the incision, are carried out on the lines advised for cerebral abscess.

Difficulties and Dangers. –

1. *No Abscess can be found.* This may be because : (*a*) it is outside the areas explored ; or (*b*) no abscess exists, the symptoms being due to suppurative encephalitis. Apply the dressing and await events. In the second case the condition may improve without further intervention. In the former, pus may make its way out through one of the punctures ; wait at least a week, if the general condition is satisfactory, before attempting to improve drainage by inserting a tube. If no abscess is found and the general condition does not improve, further exploration of the brain may be carried out without anæsthesia ; wait at least three days before doing this unless the position is desperate.

2. *The patient ceases to breathe* during or even before the operation, the heart continuing to beat. This is probably due to increasing pressure on the medulla. At once apply artificial respiration. Get the anæsthetist to pass an intratracheal catheter, through which pure oxygen can be given. This will maintain oxygenation without respiratory movement. As rapidly as possible expose the cerebellum, removing more bone than usual ; and make a wide opening in the dura. Explore the cerebellum for an abscess. As soon as the pressure in the posterior fossa has been reduced respiration may start again spontaneously ; this may be assisted by stopping the oxygen or by

adding 5 per cent of carbon dioxide to stimulate the respiratory centre. It is little use attempting this before the dura has been opened. After voluntary respiration has ceased for thirty minutes it is useless to attempt resuscitation.

After-treatment.

1. *All is Well.* As long as the general condition of the patient is satisfactory the dressings should be left undisturbed for eight or ten days ; the smell can be controlled to some extent by an outer layer of sphagnum moss. Assiduous nursing care is required, but the patient must not be 'fussed' ; let him lie in any position he chooses—elevation of the head on three or four pillows is generally preferred. A fluid diet may be needed at first, but it is often amazing within how few days a patient who has been desperately ill will demand and digest a full diet. Neglect constipation, at least for some days. For headache, administer per rectum half an ounce of magnesium sulphate in two ounces of water ; repeat if necessary. Avoid opium ; paraldehyde is safe and can be given per rectum.

Dressing. When the dressing is first changed, gently pull the tube outward a little. It may be that with the subsidence of œdema the tube extends quite across the abscess cavity and is blocked by contact beyond ; if so, pus will flow on partial withdrawal, and the tube should be removed and shortened—a somewhat wider tube may be inserted. The glycerin-gauze dressings should be continued until a fortnight from the operation ; after this gauze plentifully anointed with paraffinum molle is better. After the first dressing, the dressings should be changed every other day. The tube should be shortened only as it is literally pushed out of the brain. *Do not irrigate the cavity.* At least six weeks should be allowed before any attempt is made to close the wounds by plastic measures ; generally these are unnecessary.

2. *All is Not Well.*

a. Although an abscess has been drained the general condition remains bad, and signs of increased intracranial pressure persist, e.g., vomiting, slow pulse, intractable headache. Consider the rather rare possibilities of : (i) Coexistent cerebral and cerebellar abscesses ; (ii) Loculation in a cerebral abscess. If the latter appears probable, remove the drainage tube, and insert the gloved little finger into the abscess ; it may be possible to locate an extension and to break down the barrier to drainage.

b. After early improvement symptoms recur. Probably the drainage tube has ceased to act owing to being in contact with the further wall of the abscess ; shortening the tube may be indicated. Alternatively, the tube may have become displaced so as no longer to drain the abscess, and needs replacement.

c. Hernia cerebri.   Unless the opening in the dura has been large
this is seldom troublesome ; the cerebellum is more likely to herniate
than the cerebrum.   There is no extraordinary urgency when this
occurs.   Remember that a large cerebral hernia may contain part
of the ventricle ; do not hasten to cut it off.   If there is genuine trouble
from this condition the patient should be sent to a centre where
neurological surgery receives special attention.

Prognosis.   In the early stages there are so many possibilities
of disaster that a very guarded prognosis is necessary ; a mortality
rate of fifty per cent is better than the average expectation.   If the
immediate danger is survived, a tendency to headaches or vertigo
may persist for a long time, but the intellectual faculties are usually
undamaged.

CHAPTER LII

THE EYE AND THE ORBIT

By HUMPHREY NEAME, F.R.C.S.

SYMPTOMS AND SIGNS OF OCULAR AND ORBITAL DISEASE

THE more important symptoms and signs that suggest the presence of disease of the eye or of its surroundings are considered consecutively for comparison and for reference.

Pain. In *conjunctivitis* the patient refers only in the acute purulent type to actual pain. In most forms complaint is made of burning, soreness, irritation, or the sensation as of grit or sand in the eye. When a *foreign body* is lodged on the tarsal conjunctiva of the upper eyelid, it causes a sharp stabbing pain on blinking, unless it is situated toward the extreme outer or inner limits of the tarsus and so does not come in contact with the cornea. A similar sharp pain is produced in blinking when a *corneal abrasion* is present, and sometimes, though not always, when a small foreign body is impacted in the surface of the cornea. In all these cases relief is obtained if the eye is directed downwards while the upper lid is retracted. In *iritis* pain is more of an aching character within the eyeball, and the eye itself is tender to the touch. In *subacute or acute glaucoma* pain of a similar character is referred more commonly to the forehead, vertex, temple, and cheek of the affected side, without marked tenderness of the eyeball.

Hyperalgesia of the skin of the forehead usually indicates supraorbital neuritis.

Swelling of the Eyelids.—This may occur to such a degree as to prevent the patient from opening the eye in cases of insect bite, stye, or suppurating chalazion, especially when located towards the outer angle. A gross degree of swelling is present in erysipelas of the face affecting the eyelids, in cellulitis of the lids or orbit, in anthrax, in orbital periostitis, and in cavernous sinus thrombosis. In the orbital affections, in addition to severe constitutional symptoms and signs with pyrexia, there is proptosis of the eyeball.

Swelling of the Conjunctiva (*Chemosis*) is found in all the above-mentioned conditions that cause swelling of the eyelids, and in addition in tenonitis and in panophthalmitis.

Hyperæmia or redness of the white of the eye is of two distinct forms, which occur separately or combined : (1) *Conjunctival congestion*, except in very severe acute conjunctivitis, is more marked peripherally —that is to say, in the regions at a distance from the cornea—while the circumcorneal region remains relatively pale or almost normal in colour ; (2) *Ciliary congestion*, present especially in iritis, but also in corneal inflammations and in subacute glaucoma, affects the immediate circumcorneal region. The former, (1), is of a bright-red colour, the latter, (2), of a dull red or mauve tint. In *acute* glaucoma, as also in very severe iritis, the whole of the white of the eye may be suffused with an intense deep-red or purple-red colour. A localized patch of ciliary congestion usually indicates a localized corneal lesion.

Proptosis, as already stated, is present in the acute orbital inflammations and cavernous sinus thrombosis ; it is also produced by tumours of the orbit or of the optic nerve, but without signs of inflammation. Unilateral proptosis is sometimes due to Graves' disease.

Photophobia and Lachrymation, commonly associated in diseases of the eye, indicate injury of the cornea, incarceration of the iris or ciliary body in a penetrating wound, the presence of an intra-ocular foreign body, or inflammation of the cornea or iris.

Sudden Loss of Vision of one eye or serious impairment thereof, without external signs of disease, may be due to any of the following : (1) Vascular disturbance, including hæmorrhage in the retina or into the vitreous and obstruction of the central retinal vein or artery ; (2) Detachment of the retina ; (3) Optic neuritis from methyl alcohol poisoning ; (4) Quinine poisoning ; (5) Retrobulbar neuritis ; (6) Metastatic choroiditis. Sudden loss of vision is sometimes described by a patient who has only recently discovered a long-standing defect.

THE EYELIDS AND LACHRYMAL SAC
TRAUMA

Wounds of the eyelids in general should be treated by ordinary surgical methods. Lacerated or dirty wounds need careful cleansing

Fig. 790.—Mer-suture in curved needle.

and the removal of foreign bodies and every trace of dirt. Partial closure of the wounds is usually advisable, and dressing with moist antiseptic dressings for a few days, after which more complete repair may be carried out. Clean incised wounds which divide the tissues parallel with the lid margin heal satisfactorily by suturing and do not tend to produce deformity. Wounds at right angles to the lid margin are inclined to gape owing to division of the orbicularis muscle, and should be closed with

sutures passed sufficiently deeply to include as far as possible the divided muscle. The most careful treatment is required for vertical wounds of the margin of the eyelid in order to avoid the formation of an unsightly notch in the lid. The finest curved ready-prepared needles with silk or thread (of the Souttar or Mer-suture pattern *Fig.* 790) are of great assistance in enabling the surgeon to make a neat union of the divided parts. An attempt should first be made to insert one suture in the lid margin itself not too near the wound edge. in order to prevent the suture from cutting its way

Fig. 791. Method of suturing the lid margin in a vertical wound through the eyelid. (The needle illustrated is an ordinary eyed needle.)

out through the delicate tissues. The skin sutures should be placed at short intervals (*Fig.* 791).

INFLAMMATION

Stye (*Hordeolum*) is an acute abscess of a lash follicle which starts usually in the sebaceous gland connected with the follicle. It is of rapid onset with considerable pain, and with redness and swelling located at the lid margin exactly in the line of the eyelashes. The swelling is usually localized, but is accompanied by marked œdema of the eyelids and chemosis (œdema) of the conjunctiva when the stye is near the outer canthus. Within twenty-four or forty-eight hours a yellow centre appears on the summit of the red swelling and is the indication of impending rupture of the abscess.

Treatment. The greatest relief is obtained by very hot bathing and the frequent application of hot compresses until the yellow centre makes its appearance. At this stage the eyelash which is usually seen on the summit of the swelling should be removed by means of lash forceps (*Fig.* 792), when efficient drainage and relief from pain

FULL SIZE

Fig. 792. —Lash forceps.

generally follow. If improvement does not rapidly result, a small vertical incision is necessary. If a succession of styes should occur, attention should be paid to the general health, with the use of aperients and the correction of errors of refraction.

Suppurating Chalazion (*Meibomian Cyst*).—A chalazion is a localized swelling near the lid margin due to distension of a Meibomian gland with cellular granulation tissue. In itself it is usually painless. The swelling develops gradually, and is situated adjacent to but not at the lid margin. It usually produces a visible rounded swelling of a few millimetres' diameter whose centre is definitely some two to four millimetres distant from the line of the eyelashes. Occasionally acute suppuration follows and is accompanied by considerable pain. As in the case of a stye, when located near the outer canthus it causes marked œdema of the lids and chemosis of the conjunctiva.

Treatment.—The correct treatment is incision into the swelling via the conjunctival surface, anæsthetized by 2 per cent and 5 per cent cocaine hydrochloride drops. When suppuration is acute this is sufficient, but in a case where only a small amount of pus is evacuated in company with a collection of jelly-like granulation tissue, gentle curettage of the cavity by means of a small sharp spoon (*Fig.* 793) is necessary. If this is not done, the chalazion is very liable to recur. A discoloration of the conjunctival surface should be noted as the correct site for the incision. The eye should be irrigated for

Fig. 793. Sharp spoon.

two or three days after the operation with hot saline or boric acid lotion.

Lachrymal Abscess.—After prolonged obstruction at the lower end of the nasal duct where this structure drains into the inferior meatus of the nose, chronic inflammation of the lining mucous membrane of the lachrymal sac develops. Partly as the result of this inflammation within the lachrymal sac, and partly from the chronic conjunctivitis which it engenders, the lachrymal puncta and canaliculi fail to function. The lachrymal sac with its contained mucus, pus, and micro-organisms is then a closed cavity. The inflammation of its lining membrane increases, and, with the resulting distension, extends through the wall of the sac and sets up a peri-saccular inflammation in the surrounding connective tissue. This inflammation is generally followed by the formation of an abscess, which points immediately below the inner canthus.

Clinical History, Symptoms, and Signs.—A patient subject to such a series of events complains of watering of the eye for some months or even years, owing to the nasal-duct obstruction. With the gradual development of inflammation inside the lachrymal sac an accumulation of mucus or mucopus takes place. This mucopus

escapes from time to time into the conjunctival sac, especially with the application of pressure to the inner end of the lower eyelid. This accumulation of mucus or mucopus within the lachrymal sac is designated a *mucocele*. With the closure of the puncta and spread of inflammation to the perisaccular tissues, the patient complains of pain over the sac and swelling of the lower eyelid. Examination at this stage reveals redness of the skin, most intense just below the inner canthus, but extending to a variable degree up to the nasal side of the inner canthus and downwards and outwards into the lower eyelid and cheek. The lower lid is invariably œdematous. Great tenderness is present over the most inflamed part below the inner canthus.

Treatment. At the stage of acute inflammation, as stated, an abscess is generally formed. Resolution, however, occasionally supervenes with the application of heat by compresses and hot bathing, or by hot kaolin plaster. If the local signs indicate the presence of pus, a scalpel should be plunged directly backwards into the abscess and free drainage established. The acute signs will subside under the influence of hot bathing in two or three days. In most cases so treated a few weeks can be allowed to elapse for the more complete subsidence of inflammation, after which excision of the lachrymal sac is nearly always essential, including the fistula which may persist. Occasionally in adults, and commonly in children and infants, an abscess occurs without previous lachrymal obstruction, and the nasal duct may function again. In children and infants the incision should therefore be carried only through the skin. For details of further treatment reference should be made to a text-book on ophthalmology.

THE CONJUNCTIVA

TRAUMA

Incised or lacerated wounds of the conjunctiva of moderate extent heal satisfactorily without the introduction of sutures in the absence of severe infection. If the edges of an apparently clean wound of 8- to 10-mm. length gape apart, they can be brought to some degree of approximation by gentle stroking of the conjunctiva with an iris repositor or probe. When a wound has been inflicted by a dirty object, every effort should be made to remove visible dirt by picking out fragments as far as possible and by irrigation with normal saline. A small sharp fragment of metal is sometimes embedded in the conjunctiva so as to render it incapable of removal. In such a case the foreign body is picked up with its surrounding conjunctiva by toothed forceps (*Fig.* 794) and cut away with scissors. The resulting wound will heal in a few days.

Among school-children an injury is sometimes inflicted by an indelible (aniline) pencil. If the purple coloration of the conjunctiva

Fig. 794. Fixation forceps.

suggests this possibility, a careful search should be made for the fragment of 'lead', since this substance is intensely irritating.

INFLAMMATION

Acute Purulent Conjunctivitis. The only condition that requires consideration under the heading of inflammation, as of an urgent nature, is acute purulent conjunctivitis. It occurs in infancy under the name of *ophthalmia neonatorum*, when it nearly always affects both eyes. In these it is due to the gonococcus in less than 50 per cent of the cases, the remainder being due to the streptococcus, the pneumococcus, and rarely the *B. pyocyaneus.* Gonococcal infection takes place during the birth of the infant's head, or by careless handling at a later date. In adults—and rarely in children—acute purulent conjunctivitis of gonococcal origin affects one eye at the outset. Infection is conveyed directly to the eye by contaminated hand or finger from infected urethra or vagina.
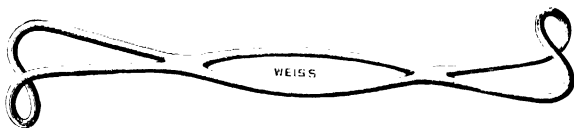
Fig. 795. Small lid retractor.

Symptoms and Signs. In the infant attention is drawn to the condition by the failure of the child to open the eyes fully when it is awakened for feeding. With this it is noticed that the upper eyelids are swollen, and the normal sulcus or groove in the skin of each upper eyelid is absent. Eversion of the lower eyelid discloses marked redness of the palpebral conjunctiva. Within twenty-four to forty-eight hours of the onset in a severe case the upper eyelids are dusky red and very prominent, and partly dried sticky yellow secretion gums the lashes together. On separation of the eyelids thick yellow pus exudes from between them. Attempts at further separation cause eversion of both lids owing to the œdematous condition of the palpebral and fornix conjunctiva. Examination of the cornea is difficult without the help of a retractor for each eyelid (*Fig.* 795.) It is impossible

without the help of an assistant who will hold the child's head firmly in position, meanwhile keeping under control its arms and body wrapped tightly in a towel. A good view of the cornea is obtained after the discharge has been partly washed and partly mopped away with lotion and cotton-wool. The slightest loss of polish or 'ground-glass' appearance of the centre of the cornea is of serious import. It is the sign of impending corneal ulceration. A drop of 2 per cent aqueous solution of fluorescein applied to the cornea, the excess being washed away with lotion, will reveal the early changes in the corneal epithelium by the appearance of a faintly greenish stippling of the surface. An area of actual loss of epithelium is stained a bright green.

The signs present in the adult affected with purulent conjunctivitis are similar, except for the fact that the condition is usually

Fig. 796. Buller's shield for the protection of a healthy eye when the fellow (is affected with purulent conjunctivitis.

unilateral. The appearance of pus is preceded by a stage of acute congestion with some sanious discharge, associated with considerable pain.

Treatment.

1. Prophylactic : The value of the preventive method of treating the eyes of infants by means of cleansing the eyelids and the instillation of 1 or 2 per cent silver nitrate drops at birth is universally recognized. In children or adults affected with acute purulent conjunctivitis, whether from gonococcal or other infection, if one eye alone is involved the other eye should be protected from infection by means of a Buller's shield (*Fig.* 796) strapped securely over it. The head should be maintained with the affected eye in the dependent position during sleep.

2. Treatment of the inflamed eye : The most important factors in the treatment are the frequent removal of secretion and the prevention of cohesion of the eyelids by dried secretion. Hourly bathing of the eye with normal saline or boric acid lotion during the day should be combined with the application of an ointment of boric acid in vaseline at night. During the night the eye should be bathed at not less than three-hourly intervals while there is profuse discharge, and on each occasion treated with the ointment. Once in two or three days 1 per cent silver nitrate solution should be applied by means of a pledget of cotton-wool on a glass rod to the conjunctiva of the everted eyelids and fornices. Silver nitrate drops applied by unskilled hands direct to the eye are liable to damage the corneal epithelium and should be avoided. In new-born children the excess of silver nitrate solution is neutralized by the application of normal saline to the conjunctiva in exactly the same manner a few seconds after the painting with the silver solution. In older children the lachrymal secretion has this effect. With the subsidence of the inflammation the use of the silver nitrate solution is stopped.

Complications. Corneal ulceration is followed by scar formation, usually over the pupillary area, and hence by impairment of vision dependent in degree upon the depth of the ulcer. Rarely in civilized countries does *perforation of the cornea* result, with consequent prolapse of iris into the wound and later *anterior staphyloma*.

Prognosis. —Good in the absence of corneal ulceration.

INJURIES OF THE EYE
NON-PENETRATING INJURIES

Burns of the Cornea are produced by the accidental entry of strong acids, as hydrochloric, nitric, or sulphuric acid ; alkalis, as solutions of caustic potash or soda, or ammonia ; or lime, as solid quicklime or freshly mixed plaster. The damage produced by any of these agents may be severe even if only a small quantity of the caustic substance gain access to the cornea. A small area of necrosis of corneal substance in front of the pupil will lead to the formation of a scar sufficiently dense to ruin the sight of the eye, even if worse complications do not supervene.

Treatment. In the case of burns by strong acid or alkali, the eyes should immediately be douched with abundance of tepid water. For acid burns, if sodium bicarbonate is available, a suitable solution may be made by dissolving a tablespoonful in one pint of water. For alkali burns, vinegar one ounce in a pint of water may be used. The most urgent procedure in the case of burns with solid quicklime is the careful removal of all fragments from the cornea and from the conjunctival sac. The eyelids should be held apart and the cornea

treated first. To relieve pain a drop of cocaine solution may then be applied if available, the lids being kept open. The upper eyelid is then everted to remove any fragments that may be lurking beneath it. Finally, free irrigation with tepid water, or preferably a 2 per cent solution of neutral ammonium tartrate, should be employed. This solution combines with the lime, and should be applied to the eye by means of an undine or a funnel and narrow rubber tube for several minutes more or less continuously. The treatment should be repeated three or four times if possible in the first twenty-four hours. Its application is painful, and may be preceded by that of a drop of 1 per cent holocaine, 1 per cent diocaine, or 2 per cent cocaine solution. After the irrigation the pupil should be dilated with 2 per cent homatropine in castor oil. Liquid paraffin should be instilled at intervals during the day, and a pad and bandage lightly applied.

Abrasion of the Corneal Epithelium may be produced in numerous ways, the commonest being by blows from blunt or rounded objects, or by a child's finger. The pain produced by such injuries is usually severe, and the eye waters freely and can only be opened with great difficulty. Within a few hours a zone of slight ciliary or circumcorneal congestion is visible. If the upper lid is retracted, the patient is able to make the eye follow the slow movements of the surgeon's finger in all directions. Careful examination of the surface of the cornea with the naked eye, in the course of which the reflex of the window or other light source is studied, reveals the smallest abrasion. A drop of 2 per cent fluorescein solution applied to the eye will stain any abraded area of the cornea a bright green, and of the conjunctiva an orange-yellow colour.

Foreign Bodies in the Cornea. Foreign bodies that are most commonly encountered on the surface of the cornea in industria areas are tiny fragments from an emery wheel, and minute spicules of steel or iron. These are detected by the same method of examination as for abrasions, and their detail studied by means of a cornea

Fig. 797. Iris repositor.

lens in light focused from a bright lamp on to the cornea. The use of the lens is essential in the removal of a foreign body in order to reduce to a minimum the damage done to the cornea by the operation. Many may be removed after cocainization by a twisted wisp of moistened cotton-wool or an iris repositor (*Fig.* 797). The foreign body is made to glide over the surface of the cornea. If it is embedded in the substantia propria, it is most readily removed with a sharp

Bowman's needle (*Fig.* 798). The needle is used after the manner of a spade, and is inserted close to one side of the foreign body, which is then levered up (*Fig.* 799, *a*). If the fragment is deeply embedded in the substantia propria, great care is required to avoid causing the point to perforate the cornea and enter the anterior chamber. The needle will in such a case require to be inserted into the cornea a very short distance away from the foreign body and made to traverse the

Fig. 798.—Bowman's needle.

substantia propria in a direction nearer to a plane tangential to the corneal surface (*Fig.* 799, *b*).

Not infrequently a ring of rust is left in the small depression formerly occupied by an iron or steel foreign body. If this is more than an indistinct stain it should be removed by careful undercutting with the needle so as to take it away with a minute disc or layer of corneal substance. If a rust ring is near the periphery of the cornea

Fig. 799.—Removal of a small foreign body (*a*) and of a larger deep foreign body (*b*) from the cornea with a Bowman's needle.

and is seen for the first time several days after the removal of the foreign body, and the eye is free from ciliary injection, it may safely be left. If on or near the pupil, it is likely, by the permeation of the neighbouring substantia propria by oxide of iron (*siderosis*), to leave a permanent mistiness of vision. In skilled hands its removal may not very appreciably increase the size or density of the resulting scar. In the case of any but very superficial foreign bodies, the application of a drop of 2 per cent homatropine hydrobromide is advisable, and if twenty-four hours later there is any ciliary injection, atropine should be used. The eye should be bandaged in cases of abrasion and after removal of foreign bodies until the epithelium has healed over.

Recurrent Abrasion of the Cornea is a temporary elevation or minute laceration of the epithelium at the site of a recent superficial injury. Its onset, commonly on waking, is associated with severe sharp pain and lachrymation which last for a few minutes to an hour

or more and then disappear. Drops of liquid paraffin should be applied
at bedtime for several weeks. In some intractable cases a mild appli-
cation of radiation from X rays or radium has been followed by the
cessation or marked amelioration of the symptoms.

Undue Exposure of the Cornea in VIIth cranial nerve palsy or
from scarring of the eyelids may lead to damage from desiccation.
A plastic operation or the operation of tarsorrhaphy may be necessary
to prevent or cure such damage.

Concussion Injuries

Injuries of the Iris. —The iris, as the result of a blow, may
suffer : (1) *Small radial lacerations* of the pupil margin (*Fig.* 800, A) ;
(2) *Iridodialysis* (*Fig.* 800, A) ; (3) *Hyphæma* (blood in the anterior
chamber—*Fig.* 800, B).
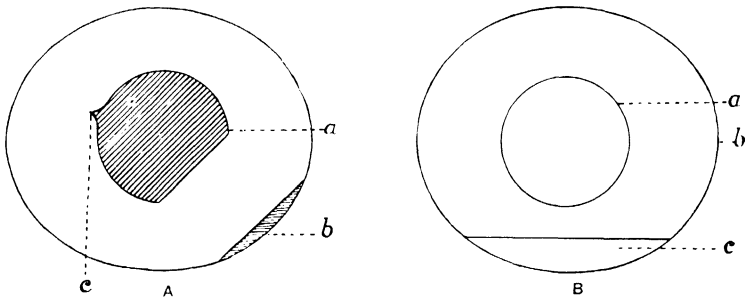
Fig. 800. A, Radial rupture of iris and iridodialysis. The appearance on exam-
ination of the eye by oblique or focal illumination in the case of a small radial rupture
of the pupil margin, and of an iridodialysis, in which are seen a D-shaped pupil and
a black band at the root of the iris. *a*, Margin of D-shaped pupil ; *b*, Tear at root
of iris ; *c*, Radial rupture of pupil margin. (These two conditions, of course, do
not necessarily occur together. The small radial rupture may occur alone, or an
iridodialysis alone.) B. This figure shows the position of a hyphæma, or collection
of blood, in the anterior chamber in the ordinary position. *a*, Pupil margin ;
b, Corneal margin ; *c*, Hyphæma.

Cyclodialysis, or separation of the ciliary body from its attach-
ment with backward displacement, is accompanied by distortion of
the pupil as shown in *Fig.* 801.

Injuries of the Lens. — The lens is liable to several types of opacity
from a blow, and these may develop into a complete cataract. The
lens may be dislocated forwards into the anterior chamber, backwards
and downwards into the vitreous, or very rarely through a scleral
rupture upwards to lie beneath the unbroken conjunctiva.

Vitreous Hæmorrhage, if moderate or slight, is detected by the
use of the ophthalmoscope at a distance of one to two feet. The eye
is made to move, being guided by the surgeon's finger, with somewhat
sudden movements. The red reflex in the pupil is then seen to be

interrupted by black clouds or streaks or spots which float from side
to side in a typical leisurely manner as the eye moves. In extreme
degrees of hæmorrhage, no red reflex can be seen through the dilated
pupil.

Injuries of the Retina.—*Detachment of the retina* sometimes follows
a blow on the eye, and is due to the occurrence of a rent or tear, usually
near the ora serrata at which the retina is attached to the junction of
the ciliary body and choroid. Through the rent, vitreous, in a state
more fluid than normal, escapes and lifts the retina away from the
choroid. A slight detachment sometimes reveals nothing more than
an abnormal degree of visibility of the retinal vessels, which appear
darker than usual. A moderate or gross detachment is suspected
when in ophthalmoscopic examination at a distance of one to two feet
the red reflex is altered slightly in brilliancy or changed in hue so as
to give a greyish or greenish appearance. This change is more notice-
able in the periphery in one direction or another. Direct ophthal-
moscopy with a — 8 dioptre lens is capable of showing that the change
in the red reflex is due to detachment of the retina and not to vitreous
hæmorrhage.

Rupture of the Choroid is rarely seen until the elapse of several
days after an injury—that is, until the vitreous hæmorrhage associated
with it has disappeared. The rent or rents in the choroid are usually
at or near the macular area and may interfere seriously with the
visual acuity, which is then permanently affected.

Injuries of the Optic Nerve.—The optic nerve may suffer serious
damage with loss of sight from hæmorrhage into the dural sheath.
Papillœdema appears, and is followed by a variable amount of optic
atrophy.

Treatment of Concussion Injuries

The treatment of concussion injuries of the eye in general consists
in rest. Especially is this so when hæmorrhage into the anterior
chamber or into the vitreous, or detachment of the retina, is present.
Hæmorrhage is not likely to increase after twenty-four hours. Cold
compresses help to relieve pain during this time, and atropine helps to
rest the eye by paralysing the ciliary muscle. Extensive vitreous
hæmorrhage is well absorbed in young patients, but may take several
weeks to disappear. In older people it is liable not to be absorbed
completely, or to be replaced by fibrous tissue bands (retinitis proli-
ferans).

Successful treatment in a larger proportion of cases of detachment
of the retina than heretofore is obtainable by sealing up the hole in
the retina by means of diathermic cauterization by a very careful and

accurate technique. The operation is known as cautery-puncture. The technique of accurate localization of the hole in the retina is of such extreme importance, and the correct application of the electrocautery so essential, that this operation should be performed only by a surgeon accustomed to operating on the eye. Furthermore, operation is not of such urgency that delay of a week or two has any obvious effect on the prognosis.

PENETRATING INJURIES WITHOUT RETENTION OF A FOREIGN BODY

Cases of this category may be grouped under the following headings: (1) Corneal wounds; (2) Corneo-scleral wounds; (3) Sclerotic wounds. The question of retention of a foreign body is considered afterwards.

Wounds of the Cornea.

1. *Slight perforating wounds of the cornea without damage to structures within the eye* are detected by observing the corneal reflex of the source of illumination and by noting the irregularity of the image. Under close scrutiny of the eye, the patient is directed to follow the surgeon's finger moved in every direction. If there is any doubt, a drop of 2 per cent fluorescein solution should be placed on the sclera immediately above the cornea. This will stain the corneal wound a bright green colour. The escape of aqueous humour produces a shallow anterior chamber. The tension also is reduced very markedly.

2. *In peripheral corneal perforating wounds,* prolapse or entanglement of a portion of the iris in the wound is common. The iris may be prolapsed through the wound and appear as a black nodule above the surface of the cornea, or be incarcerated within the deep lips of the wound. The diagnosis is of very great importance, for upon successful treatment may depend the safety of the eye. A prolapsed iris left untreated is almost certain to lead to intra-ocular inflammation of a severe degree.

3. Penetration of the eye by an instrument which passes deeper is associated with injury to the lens. The wound of the lens capsule results in traumatic cataract. The lens becomes completely opaque, and soft swollen lens matter may herniate into the anterior chamber, or, in the case of a central corneal wound, prolapse through the cornea. If the anterior chamber remains to some extent, the opaque lens may slowly become absorbed by the aqueous.

Wounds at the Corneo-scleral Junction, or immediately above it, are more serious than corneal wounds, in that they are invariably associated with iris or ciliary-body prolapse. This leads to risk of infection of the eye, and its necessary removal if serious inflammation should supervene. *Fig.* 801 shews the condition of the iris

and the position of the prolapse, which appears as a black mass projecting above the surface of the eye.

Wounds of the Sclera.—Scleral wounds are of less risk to the eye than those just considered, as there is less likelihood of prolapse of uveal tissue; but there may be prolapse of the vitreous, extensive
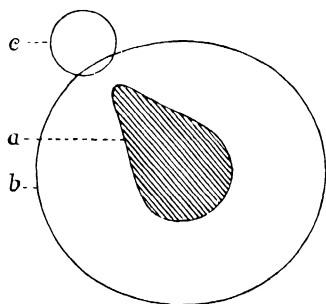
Fig. 801. Corneo-scleral wound with iris prolapsed. The appearance of the pupil in a case of penetrating wound at, or near, the corneo-scleral junction in which the iris has prolapsed. *a*, Pupil drawn towards the wound ; *b*, Corneal margin ; *c*, The circle represents the situation of a bulge or prominence at the site of prolapse, in examination by daylight or focal illumination. The prominence is usually black in colour (uveal pigment).

hæmorrhage into the vitreous, and later fibrous-tissue formation within the eye causing detachment of the retina.

It is of great importance to regard all cases of penetrating wound of the eyeball as likely to be complicated by the retention of a foreign body until this is definitely disproved.

RETENTION OF A FOREIGN BODY IN THE EYE

The examination of the eye with the corneal lens under focal illumination, and by means of the ophthalmoscope, may elicit the fact that a penetrating wound is present, but fail to disclose the presence of a foreign body. To determine this, if possible, is of great import-ance. The history of the injury may give an indication. Injury to an eye which occurs during the use of a cold chisel and hammer, or during stone-breaking, or through the bursting of a bottle containing effervescent drink, may be accompanied by the entry of a fragment of steel or stone or glass respectively. Secondly, the careful examin-ation of the eye may reveal, in addition to a corneal or scleral wound, a hole in the iris or in the lens capsule. Thirdly, radiographic examin-ation is capable of revealing the presence of an opaque foreign body and of its accurate localization. When a metallic foreign body is very small, or when a fragment of flint or glass is within the injured eye, the shadow may be indistinguishable in the ordinary radiograph of the head. In injuries by such small fragments the foreign body is usually arrested in the anterior third of the eye. It is then capable of being demonstrated, although not accurately localized, by a method of radiography recently introduced. A dental film is pressed back-wards between the eyeball and the nasal part of the orbital margin in the sagittal plane. The X-ray tube is placed laterally, so that the

shadow of the anterior part of the eye is cast upon the film. By the use of a 'soft' X-ray tube the shadow even of a small spicule of glass within the angle of the anterior chamber, the lens, iris, or ciliary body is capable of demonstration. Fourthly, in the absence of facilities for immediate radiography—but only available in ophthalmic hospitals or the larger general hospitals—is the method of examining the patient with the Haab or Mellinger eye magnet. As the demand for the use of this apparatus is not frequent, and as its manipulation requires the knowledge of a very special technique, further details of this method are considered to be beyond the scope of this book. For the general surgeon upon whom devolves the responsibility of making the decision as to the disposal of a case of penetrating injury of the eye, a careful study of the history, combined with thorough examination of the eye, will in most cases provide the necessary information.

Fragments of iron that penetrate the eye are sometimes sterile from being heated, but if left, cause siderosis—a dissemination of oxide of iron in the iris, lens, or retina, with gradual destruction of vision. Copper usually produces a destructive inflammation of the eye. Stone fragments are commonly septic. Glass, if clean, may remain in the eye without producing any damage beyond the mechanical injury of its penetration and of the sequelae thereof.

Treatment.—Only in exceptional circumstances or situations will the general surgeon be called upon to operate on such cases. In the rare case of a foreign body of moderate dimensions partly within the eye and projecting out through the sclerotic or cornea, he may withdraw the object by means of dissecting or artery forceps. If necessary the wound may be enlarged slightly to facilitate the removal of a firmly impacted body. The preparation of a conjunctival flap to cover the wound (*see* pp. 796, 797) should precede the removal of the foreign body. When access to the services of a competent ophthalmic surgeon is absolutely impossible, two courses are open. An eye that has suffered a moderately severe injury and that is suspected of containing a foreign body may be enucleated at once if prolonged supervision is not available. Otherwise such a case should be examined carefully every few days to note (1) the persistence of photophobia and lachrymation, (2) the failure of the ciliary or circumcorneal congestion to diminish, (3) the development of keratic precipitates ('K.P.'). If during a fortnight's observation from the date of injury there is no definite diminution of redness, or if 'K.P.' is seen, enucleation should be performed in order to prevent the onset of sympathetic ophthalmia. In other circumstances, cases suspected of harbouring a foreign body within the eye should be seen at the earliest possible moment by an ophthalmic surgeon experienced in treating them. In addition, as already stated, any case of penetrating injury should

be regarded as suspect until the presence of a foreign body has by all methods of examination been disproved.

RUPTURE OF THE EYE

This condition is usually produced by a blow from a large object such as a fist, or occasionally from a small hard ball such as a golf ball or a rackets ball. The usual position for the rupture is just posterior to the corneo-scleral junction in the superior nasal quadrant (*Fig.* 802). It is recognized by the history, with the occurrence of extreme
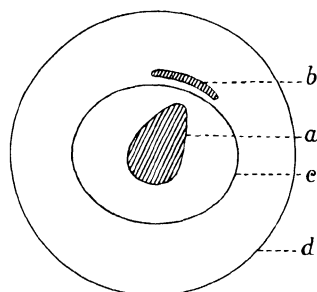
Fig. 802. Scleral rupture, right eye. Shows the situation of the most common type of rupture (right eye) as examined in daylight or by focal illumination. *a*, Pupil drawn upwards and inwards towards the rupture; *b*, Site and common extent of the rupture, just posterior to the corneo-scleral junction; *c*, Corneal margin; *d*, Equator of the eye.

pain at the time of injury, a very congested eye, flabby, and showing a dark line or projecting dark mass at the site of rupture.

COMPLICATIONS OF PENETRATING INJURIES

Ulcer of the Cornea from corneal abrasion.

Panophthalmitis, or suppuration within the eye, with pus formation in the aqueous or vitreous chamber.

Sympathetic Ophthalmia. This is a plastic inflammation of the uvea of the fellow eye. It occurs after an interval usually of two weeks or more. It is rare, but of great importance, for it commonly results in almost complete blindness in both eyes.

TREATMENT OF PENETRATING INJURIES

Simple Non-lacerated Wounds of the Cornea, not complicated by infection, usually heal rapidly under treatment with atropine, hot bathing with boric acid lotion, and the application of a pad and bandage.

Lacerated Wounds of the Cornea.—After careful cleansing, it is necessary to cover these with a conjunctival flap if they gape and allow persistent leakage of aqueous humour. The method of carrying out this procedure is indicated in *Fig.* 803, where the wound of the cornea is not central. The conjunctiva is divided as near as possible to the corneal margin, undermined with scissors as far as the

insertion of the rectus muscles, and sutured as indicated so that it is drawn down over a considerable portion of the cornea. If the wound is central, this method of covering is not quite so certain as by undermining the conjunctiva all around the cornea and drawing it together with a purse-string suture. The conjunctiva quickly becomes adherent to the wound and prevents any leakage of aqueous. As the sutures cut through the conjunctiva in the course of a few days, the parts which are not attached to the wound gradually retract and finally take on practically a normal appearance. These methods of operation are only rarely necessary, and always result in the formation of a dense corneal scar. After the operation, the oral administration of urotropine 10 gr. three times daily, with acid sodium phosphate 20 gr., is adopted. In cases of severe infection, the cornea is liable to slough, pus to form in the anterior chamber, and inflammation to extend
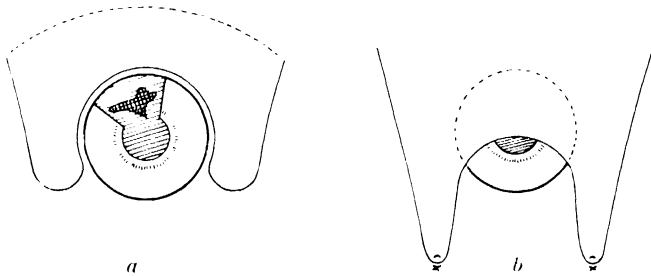
Fig. 803. Method of covering a gaping corneal wound with conjunctiva. a, Indicates the outline of the flap to be dissected up from below. The dotted line shows the extent to which the conjunctiva is undermined upwards. b, Indicates the position of the conjunctiva after two sutures have been inserted, drawing the flap down (like a blind) over the cornea.

also into the vitreous cavity with the formation of pus therein (panophthalmitis). The treatment of this condition is either evisceration of the eye in very acute cases, or enucleation where the inflammation is of moderate severity (see pp. 800, 801).

Prolapse or Incarceration of Iris in a Corneal Wound: Iridectomy. —Much depends on the skill, backed by experience, with which this operation is performed. Except, therefore, in places far removed from civilization or devoid of access to an ophthalmic surgeon, it should not be lightly undertaken by the general surgeon. In addition to the signs of perforation of the cornea already mentioned, there is visible a black and usually rounded projection on the surface of the cornea at the site of the wound. Through the cornea the iris is seen passing forwards close against its posterior surface to the wound, and the anterior chamber is observed to be absent.

Iridectomy.—The operation should be performed if possible

within a few hours of the time of prolapse. Excellent results follow, however, upon operations carried out even days after the injury. A general anæsthetic is administered. After gentle irrigation of the eye with normal saline, the eyelids are held open with a speculum (*Fig.* 804). With capsule forceps (*Fig.* 805) or, failing them, a pair of fixation forceps — held in the right hand, the prolapsed portion of the iris is seized and drawn further out through the wound; a fresh hold of the prolapse is then taken close to the cornea with the iris forceps (*Fig.* 806) held in the left hand; the iris is drawn forwards a little further with side-to-side movements to allow each pillar of iris to slip through the wound: de Wecker's iris scissors (*Fig.* 807), held in the right hand are then applied astride of the iris, and with their blades flat on

Fig. 804. — Eye speculum.

Fig. 805. — Capsule forceps.
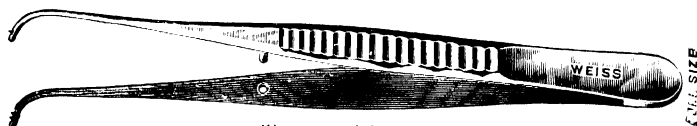
Fig. 806. — Iris forceps.

the corneal surface and pressing slightly against it, are made to cut off the whole of the prolapse with one cut. Gentle manipulation of the cornea with an iris repositor (*see Fig.* 797) will often free the
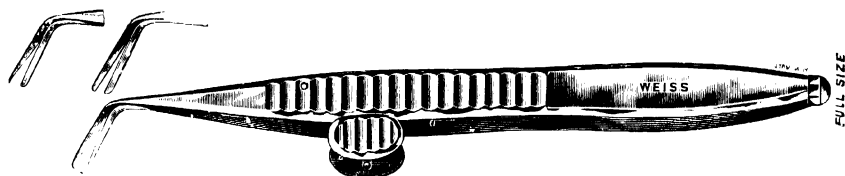
Fig. 807. — De Wecker's scissors.

stretched pillars of iris if the wound is not at the periphery of the cornea. Otherwise an iris repositor is inserted at one end of the wound and by one sweeping movement made to stroke or push the iris pillar and set it free on that side, and then another iris repositor is inserted at the

other end of the wound to free the opposite pillar. If the corneal wound remains gaping, it should be covered by a conjunctival flap as already described. A pad and bandage are applied, and daily gentle irrigation, and instillation of atropine drops, are the essentials of after-treatment.

If the iris is not actually prolapsed through the wound, but merely incarcerated or entangled within the deep lips of the wound, the incarceration may be abolished by means of drops in some cases. Where the corneal wound is peripheral, drops of $\frac{1}{2}$ per cent eserine sulphate should be administered half-hourly to contract the pupil to the utmost. If the wound is near the centre of the cornea, the pupillary border of the iris will be incarcerated, and in this case 1 per cent atropine sulphate drops should be administered in order to dilate the pupil. If this proves insufficient, although the pupil may become contracted or dilated respectively, the iris may be made to assume its normal position by gentle manipulation of the cornea with an iris repositor under a local anaesthetic.

Apart from the exception referred to above, atropine should be used invariably in the treatment of corneal wounds to prevent the formation of posterior synechiae. In patients over 40 years of age, it should not be used stronger than $\frac{1}{4}$ or $\frac{1}{8}$ per cent for fear of the onset of glaucoma.

Corneo-scleral Wounds. In this situation the wound is invariably complicated by some degree of prolapse of the ciliary body or root of the iris. The prolapsed uveal tissue should be removed flush with the surface of the eyeball by means of de Wecker's scissors. The conjunctiva should be freely undermined as described above, if necessary in a slightly modified manner, and drawn over the wound, care being taken that the conjunctival flap is as thick as possible.

Scleral Wounds should be covered with conjunctiva by undermining and suturing. In cases of large scleral wounds with prolapse of vitreous, excision of the eye is necessary.

THE INDICATIONS FOR EXCISION OF AN EYE that is the subject of a perforating wound or rupture are as follows :—

1. A large wound, especially associated with lens injury.

2. Extensive vitreous loss or prolapse of ciliary body, choroid, or retina. Collapse of eyeball.

3. Loss of vision, in most cases.

4. Evidence of existence of a foreign body of considerable size within the eyeball—more than 5 mm. in each direction—which cannot be easily removed.

5. Persistence of 'K.P.' or ciliary congestion *in cases in which no definite diminution of these physical signs is detected within fourteen days of the date of injury.*

6. The development of panophthalmitis. (In very acute cases of this condition evisceration (*see* p. 801) should be performed instead of enucleation, in order to avoid the risk of spread of infection to the meninges by the dural sheath of the optic nerve.)

Enucleation of the Eye. This operation is usually performed under a general anæsthetic, but may be performed after conjunctival and retro-ocular infiltrations with one drachm of 2 per cent novocain containing 4 min. of 1 1000 adrenalin aided by a previous subcutaneous injection of morphia. The description of the operation applies to the right eye, with the surgeon standing at the head of the operating table. An eye speculum (*see Fig.* 804) is inserted, and with fixation forceps (*see Fig.* 794) the conjunctiva is seized close to the limbus on the temporal side. The conjunctiva is divided as close to
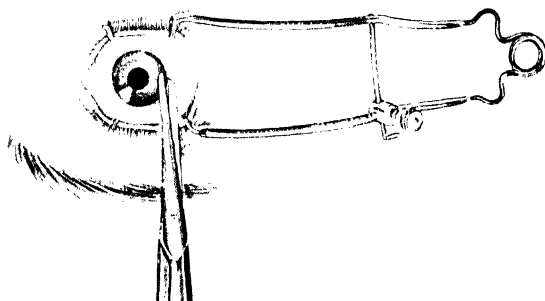
Fig. 808.　Enucleation of the right eyeball: dissection of the conjunctiva. Since the surgeon stands at the head of the table the eye is shown upside down.

the cornea as possible, and one blade of small round-ended scissors is inserted (*Fig.* 808) and made to cut the conjunctiva free from the limbus, working downwards and gradually round to the nasal side. The upper conjunctival attachment is then treated similarly. During this process the two blades of the scissors are from time to time passed beneath the conjunctiva and opened forcibly so as to separate this membrane from the sclera. Tenon's capsule is then seized by the forceps above the tendon of the internal rectus muscle and an opening made into it. A squint hook (*Fig.* 809) or one blade of dissecting forceps—is passed beneath this tendon to define the passage for the scissors, one blade of which is then inserted beneath the tendon. The latter is divided close to its insertion, and its expansions above and below are defined by the hook and divided. The tendons of the superior and inferior rectus are divided next. The

hook is passed beneath the external rectus and the scissors made to cut the tendon external (temporal) to the hook so as to leave a portion of the tendon attached to the eyeball. The hook is passed all around the eyeball to pick up any remnants of tendinous expansions or of Tenon's capsule attached to the fore part of the globe so that these bands may be divided. The speculum is now pressed backwards into the orbit so as to dislocate the eyeball forwards. The stump of the external rectus is held by fixation forceps and the eyeball rotated towards the nose so as to stretch the optic nerve. Closed scissors are used to define the position of the stretched nerve by feeling above and below it, and then it is divided with one clean cut. Ordinarily the nerve is cut close to the back of the eyeball, but in cases of intra-ocular neoplasm the ends of the scissors are pushed backwards into the orbit so as to divide the nerve as far back as possible. The eyeball is now almost free, and is removed by division of the insertions of the oblique muscles. Gauze pressure in the orbit usually arrests hæmor-rhage quickly. If necessary, very hot saline can be used. The con-junctiva can be closed without sutures by approximating its edges

Fig. 809. Squint hook.

and pinching the cut edges together with fixation forceps. A grad-uated pressure dressing is applied over the closed eyelids and bandaged firmly. At the dressing on the following day the bandage can be applied lightly. Irrigation of the socket with saline or boric acid lotion from once to three times daily is employed according to the amount of discharge from the conjunctiva.

Evisceration of the Eyeball.—This operation is performed in cases of panophthalmitis, in order to avoid the risk of meningitis through extension of infection from Tenon's capsule into the subdural space opened by division of the optic nerve in the operation of excision. It consists in excision of the entire cornea, and removal of the whole contents of the eyeball with a special scoop or by means of dissecting forceps. After the removal of the bulk of the ocular contents, the inside of the sclerotic is thoroughly and carefully cleaned out with gauze swabs to ensure that no trace of uveal tissue shall remain.

IRIDOCYCLITIS AND GLAUCOMA

A detailed consideration of this subject is impracticable in the space available. Although iritis is an urgent condition, its local treatment is essentially medical, and seldom likely to come within the

field of the general surgeon. In certain cases, however, when acute glaucoma is the result of acute iritis or iridocyclitis, the surgeon may find himself in difficulties unless he has some knowledge of these conditions. A comparison only of the symptoms and signs of chronic and acute glaucoma and iridocyclitis is made in the accompanying table.

DIFFERENTIAL DIAGNOSIS OF GLAUCOMA AND IRIDOCYCLITIS

	CHRONIC GLAUCOMA (NON-CONGESTIVE)	ACUTE GLAUCOMA (CONGESTIVE)	IRIDOCYCLITIS
History	Premonitory transient attacks of misty vision with haloes and pain, which last a few hours and then pass off	Premonitory transient attacks of misty vision with haloes and pain, which last a few hours and then pass off	In previous attacks, failure of vision, if noticeable, would have lasted *weeks*, not hours (' K P.' and vitreous opacities). No haloes
Visual acuity	Very slight depreciation till late	Rapid and serious failure Haloes and coloured rings around lights*	Loss commensurate with amount of 'K.P.' and vitreous floating opacities. Mistiness
Field	Gradual contraction of visual field	Vision so poor that fields cannot be taken	
Pain..	Slight or absent	Severe, referred chiefly to forehead and temple (pressure on ciliary nerves)	In the eye, and tenderness over the ciliary region (absent in cases free from ' ciliary congestion ')
Congestion ..	Absent	Widespread purple-red congestion over sclerotic	Ciliary (or circumcorneal) congestion
Cornea	Normal	Steamy, with minute clear black superficial bullæ visible with a lens (œdema of epithelium)	Slight haziness occasionally, due to deep corneal striation (œdema of substantia propria). Also ' K. P.'
Anterior chamber	Shallow	Shallow	Normal or deep
Exudate	None	None	' K. P.' on deep corneal surface. In the anterior chamber. Floating vitreous opacities

* Haloes and coloured rings round lights may occur in conjunctivitis owing to the presence of a flake of mucus or mucopus on the cornea. They are abolished by blinking or bathing the eye.

DIFFERENTIAL DIAGNOSIS OF GLAUCOMA AND IRIDOCYCLITIS—*continued*

	CHRONIC GLAUCOMA (NON-CONGESTIVE)	ACUTE GLAUCOMA (CONGESTIVE)	IRIDOCYCLITIS
Pupil	Slightly enlarged, sluggish contraction badly maintained	Dilated, oval or pear-shaped ; fixed	Small, irregular. On dilatation with my-driatic becomes fes-tooned owing to posterior synechiæ unless annular syne-chiæ are present. Brown pigment spots on anterior surface of lens
Iris	Pale patches of atro-phy in severe, long-standing glaucoma	Pale patches of atro-phy in severe, long-standing glaucoma	Discoloration of iris due to vascular en-gorgement and exu-date
Optic disc ..	Cupping ..	Fundus invisible, due to corneal haze	Normal
Tension ..	Slightly raised	Much raised	Usually normal or subnormal
Effect of treatment	Very little, if any, improvement in vision or return of field loss. Arrest of progress in early cases	Considerable rapid improvement of vision	Gradual improvement of vision concurrent-ly with absorption of ` K. P.' and floating vitreous opacities

Primary Glaucoma is a condition of raised intra-ocular tension the absolute causes of which are not known, although many contribu-tory factors are recognized. It is due to diminished outflow of aqueous humour from the eye, and occurs in an acute form as *congestive glaucoma*, in a chronic form as *non-congestive glaucoma*, or in grades of intermediate severity.

Secondary Glaucoma may also occur in a congestive, non-conges-tive, or intermediate form. It is the result of some known and recog-nizable affection of the eye. The causes are numerous, and may be divided into traumatic, inflammatory and circulatory, and neoplastic. Many different types of injury are liable to produce glaucoma. The most important inflammatory cause is iridocyclitis, and of circulatory disturbances may be mentioned severe intra-ocular hæmorrhage and thrombosis of the central vein of the retina. Intra-ocular growths, most commonly choroidal sarcoma, sometimes indicate their presence by the onset of glaucoma ; on the other hand, they are occasionally masked by the hazy cornea or cataractous lens due to the glaucoma they have produced.

Treatment of Acute or Congestive Glaucoma

When the diagnosis of acute glaucoma has been made, the following forms of treatment should be employed :—

1. Rest in bed with vigorous purging.
2. Hot bathing of the eyes or hot compresses.
3. The application of two leeches to the temple.
4. The administration of drops of 1 per cent eserine sulphate in castor oil half-hourly for two hours to the affected eye, and then two-hourly. It is well to apply them once also to the sound eye. Continued use of 1 per cent solution causes conjunctivitis.
5. The hypodermic injection of morphia, gr. ¼.
6. If after two hours there is little or no relief from pain and no reduction in tension of the eye, an intravenous injection of 30 per cent (saturated) solution of sodium chloride should be made. The quantity to be injected is calculated at the rate of 1 c.c. of solution per kilo. of body weight (Duke-Elder), or 50 c.c. for an adult of medium weight. It should be introduced slowly over a period of ten minutes with the patient in a reclining position. Fluid by the mouth should be given only in minimal quantities unless the patient shows signs

Fig. 810. Graefe cataract knife.

of distress, as may happen in old age from a fall in blood-pressure. This treatment reduces the ocular tension by altering the osmotic tension between the ocular fluids and the circulation, by abstracting fluid from the eye. Its effect, while useful in rendering the eye more suitable for operation, does not last much longer than twenty-four hours.

7. In the rare contingency in which it is impossible for the patient to obtain early access to an ophthalmic surgeon, as when the general surgeon is far removed from civilization, a further procedure will help to preserve the eye from total blindness when the tension is not reduced by other means. It is known as *scleral puncture*. It is performed under local anaesthesia by raising the ocular conjunctiva with fixation forceps at about 10 mm. from the cornea in the inferior temporal quadrant and drawing it towards the cornea, and then slowly passing a small Graefe cataract knife (*Fig. 810*) through the sclerotic vertical to the surface of the eyeball. The knife is held with its back towards the cornea and its edge towards the posterior pole of the eye, and is introduced to the extent of about 5 mm. directly towards the centre of the eyeball. It is then turned through an angle of from 45° to 90° to allow the escape of some vitreous into the subconjunctival tissue. The knife is turned back again and withdrawn, and the conjunctiva is allowed to slide back into place so that the scleral and conjunctival

wounds do not coincide. This operation infallibly reduces the tension, and may be repeated two or three days later if necessary, but naturally at the cost of some permanent damage to the eye.

In all cases of primary congestive glaucoma, the patient should undergo operation at the hands of one accustomed to perform eye operations. The operation of choice in the acute congestive stage is a broad iridectomy.

THE ORBIT
TRAUMA

Among injuries affecting the orbit are to be included contusions, wounds, orbital hæmorrhage, fracture of the bony walls, and retention of foreign bodies.

Dirty objects which have penetrated the orbit are liable to produce orbital abscess or cellulitis. A contusion of the bony orbital margin may cause periostitis. The optic nerve is subject to injury or complete division by a penetrating object, with consequent optic atrophy. This structure suffers similar damage in fractures of the base of the skull which severely implicate the optic foramen.

Deep penetration as by a bullet sometimes causes an *arteriovenous aneurysm* of the carotid artery and cavernous sinus. Rarely does spontaneous cure of the aneurysm follow. Occasionally the condition is stationary. Generally the proptosis and damage to the eye are steadily progressive. The signs and symptoms are noises in the head, which are usually distressing; proptosis with swelling around the eye; an expansile pulsation; and a thrill with a bruit on stethoscopic examination. Treatment is by ligature of the common carotid artery, or the internal carotid, or of the internal and external at the same operation in a healthy young subject. Compression of the carotid artery may be used as a test to indicate the risk of operation through cerebral anæmia. Vertigo, motor and sensory limb disturbances, or loss of consciousness are contra-indications to the operation. In a number of cases of carotid-cavernous-sinus aneurysm from various causes, ligation of the common carotid gave less than a 10 per cent mortality. Ligation of the internal carotid is more difficult, but lessens the probability of excessive collateral circulation. The mortality appears to be about the same as that of commonlcarotid ligature, but the chances of improvement or cure somewhat better (Huddy). Wilfred Trotter says: " In dealing with these aneurysms the risk of doing an inadequate operation is greater than that of damaging the nutrition of the brain. The treatment by common carotid ligature is defective because it allows blood from the external carotid—freely supplied across the middle line of the face—to pass down through the bifurcation into the internal carotid and so to reach the aneurysm.

Ligature of the internal carotid itself, again, may be ineffective, because it allows blood to pass up the external carotid and through the orbit to the aneurysm. Clearly, then, two ligatures are necessary to give the fullest possible control of blood to the aneurysm. These may be applied to the two branches above the bifurcation, or, as is sometimes more convenient, to the common and external carotids. A transverse incision with longitudinal splitting of the sternomastoid is used. It gives direct access to the vessels and avoids the permanent depression in the contour of the neck that is apt to follow the usual displacement of the muscle. The operation in itself is trivial." (For the technique of carotid artery ligature, see Chapter XXXII.)

TREATMENT OF ORBITAL WOUNDS

In the treatment of proptosis resulting from haemorrhage from wounds of the ophthalmic artery or its branches, or of the ophthalmic veins, it is usually sufficient to enforce absolute rest in the reclining position in conjunction with the hypodermic injection of morphia.

Incised and lacerated wounds of the skin around the eye should be treated by ordinary surgical methods. After cleansing the skin with a sterile gauze swab made merely damp with a weak solution of iodine in spirit, wounds which penetrate deeply into the orbital tissues should in general, apart from the removal of obvious foreign bodies, be left undisturbed. Undue manipulation in the attempt to find a deep foreign body is liable to lead to loss of the eye. If septic, such a foreign body will cause the formation of an abscess which will track forwards. Incision into the abscess will disclose the track to the foreign body. A particularly irritating foreign body which occasionally gains entrance to the anterior parts of the orbit is a piece of the lead of a copying pencil (aniline). If assistance is available, the wound may be stretched open by two narrow retractors and more readily examined by the surgeon with the help of toothed forceps (eye-fixation forceps). In narrow deep wounds, unless produced by a comparatively clean article, a strip of rubber tube should be inserted for twenty-four or forty-eight hours. If orbital cellulitis should supervene, treatment by free opening up of the wound for efficient drainage is essential.

INFLAMMATION

The term 'inflammation of the orbit' includes periostitis, orbital cellulitis, and cavernous sinus thrombosis, and from these conditions it is necessary to differentiate tenonitis, which causes less distress to the patient so affected and is of no danger to life.

Acute Periostitis of the orbit may follow contusion of the bony margin, also inflammation of accessory nasal sinuses, in particular the ethmoid cells.

Orbital Cellulitis may arise : (1) By extension of inflammation from erysipelas of the face ; (2) From wounds of the orbit with infection or introduction of a foreign body, or after operations on the orbit ; (3) From neighbouring foci of inflammation, e.g. periostitis of the orbital wall, dental abscess, accessory nasal sinus inflammation—the commonest cause in cases that do not arise from wounds is inflammation in the ethmoid air cells ; (4) From general causes such as metastasis in pyæmia, septicæmia, or acute specific fevers (e.g., influenza, scarlet fever, small-pox).

Course. Orbital cellulitis may subside and the affected structures resume their normal appearance and function, or slight proptosis may remain. More commonly an orbital abscess is formed.

Complications. Ocular palsy, optic atrophy, or panophthalmitis may supervene, and in the most severe cases thrombosis of the cavernous sinus, meningitis, or cerebral abscess may develop.

Cavernous Sinus Thrombosis.—Infective thrombosis may arise (1) by extension of this process already present in the ophthalmic veins or in the petrosal sinus, or (2) as a metastatic infection in pyæmia, septicæmia, or specific fevers. The first method follows any of the causes enumerated above for orbital periostitis or cellulitis, with the addition of extension from infection of tonsils, teeth, or petrous bone.

Tenonitis is a non-suppurative inflammation of Tenon's capsule, It occurs in panophthalmitis and in penetrating wounds involving the capsule. Sometimes no cause can be assigned to it, or merely a gouty or rheumatic tendency.

SYMPTOMS, PHYSICAL SIGNS, AND DIAGNOSIS OF ORBITAL INFLAMMATION

For convenience of comparison the symptoms and signs of these inflammatory conditions are arranged in the accompanying table.*

	PERIOSTITIS, EXCLUDING CHRONIC FORMS	CELLULITIS	CAVERNOUS SINUS THROMBOSIS	TENONITIS
History of onset	Sudden ..	Sudden ..	Sudden ..	Sudden
General condition	Malaise .. Pyrexia	Malaise Pyrexia	Extreme malaise Pyrexia	Slight malaise
Appearance ..	Ill	Ill	Seriously ill ..	Well
Diplopia ..	Present if eye is in a position of deviation	Present if eye is in a position of deviation	Vision impaired early (extreme orbital œdema)	On attempting to turn eyes
Pain	Severe	Severe ..	Throbbing ..	Pain on trying to turn eyes

* From Neame and Williamson-Noble's *Handbook of Ophthalmology*, Churchill, London, 1927, pp. 238-9.

SYMPTOMS, PHYSICAL SIGNS, AND DIAGNOSIS OF ORBITAL INFLAMMATION—*contd.*

	PERIOSTITIS, EXCLUDING CHRONIC FORMS	CELLULITIS	CAVERNOUS SINUS THROMBOSIS	TENONITIS
Tenderness ..	Localized to site of bone lesion if at the orbital margin	No localized tenderness	No localized tenderness	None, except on backward pressure on the eyeball
Eyelids ..	Red and swollen	Red and swollen	Extreme dusky redness and swelling	Moderate or slight swelling
Conjunctival chemosis	Marked	Marked ..	Marked ..	Well marked
Proptosis ..	Present in deep or posterior orbital periostitis : slight in periostitis of orbital margin	Present ..	Extreme ..	Slight
Proptosis direction	Varies with site of origin of periostitis	Mainly directly forwards	Mainly directly forwards	Mainly directly forwards
Unilateral or bilateral	Unilateral ..	Unilateral ..	Often bilateral in later stage	Unilateral
Movement of eyeball	Varying with degree of proptosis	Varying with degree of proptosis	Varying with degree of proptosis	Marked limitation in comparison with slight degree of proptosis
Palpable localized swelling	In periostitis of orbit margin, or pointing abscess			
Mastoid œdema	—	Gland behind ear swollen	Sometimes present (thrombosed petrosal sinus)	..
Cerebral symptoms	—	If meningitis supervenes	Develop quickly	
Vision	—	Impaired if nerve also inflamed	Found impaired if able to be tested	
Fundus ..	Normal	Optic neuritis if anterior end of nerve involved	Distension of retinal veins ; sometimes papillœdema	—
Prognosis ..	Fair in anterior periostitis ; in posterior, grave	Grave ; risk of meningitis	Fatal ..	Good

Treatment of Inflammation of the Orbit

Treatment of the Cause. —Cleansing and free drainage of obviously infected wounds and the removal of foreign bodies are essential in traumatic cases. Examination of the teeth, nose, and throat should be made, and include where possible transillumination and radiography of the accessory sinuses. Suitable treatment should be carried out upon any septic foci likely to be the cause of the orbital condition.

General Treatment. —This should include thorough evacuation of the bowels, and diaphoresis if warranted in view of the condition of the patient.

Local Treatment. —The application of heat by moist dressings, such as hot compresses or china clay (kaolin) paste, relieves pain and hastens the pointing of an abscess. If the localized dusky coloration of the skin or localized induration gives an indication as to the possible

Fig. 811. Incision used for drainage in a case of cellulitis of the orbit. Recovery followed.

site of an abscess, a scalpel should be plunged directly backwards in this area. In periostitis the knife should incise the periosteum in the affected part. The position of the eyeball sometimes indicates the centre of the inflammation. For example, a downward and outward displacement of the eyeball suggests the presence of pus in the upper and inner part of the orbit. In this case incision should be carried deeply through the upper lid between the eyeball and the roof of the orbit, and parallel to the latter. When a high degree of proptosis and severe constitutional signs are present, delay is inadvisable, even in the absence of localizing signs. A scalpel should then be introduced through the upper and lower eyelids near the orbital margin and carried well back into the posterior parts of the orbit (*Fig. 811*). Care should be taken to avoid the pulley of the superior oblique muscle

placed anteriorly in the upper and inner angle of the orbit. A small tube or strip of rubber should be inserted as deeply as possible into the wound.

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APPENDIX

Since writing this edition (which has taken a long time to produce) further experience and recent articles have rendered it advisable to add the following comments before the work is published.

Page 3.   Continuous Intravenous Saline.— Even if the solution has been prepared with distilled water and sealed capsules of the concentrated salt and glucose solution—which it should be—it must be brought to the boil before use.   If a cannula is employed the vein should be exposed with every aseptic precaution, the surgeon wearing gloves.   The top of the container must never be left uncovered. The nurse in charge of the apparatus must be warned about this, and of her responsibility in keeping the container filled with absolutely sterile solution.   I have been putting a little mercurochrome in the solution – sufficient to make it just pink—and I believe this reduces the number of 'reactions', which in my practice have not been frequent.   I have been employing a vein in the arm more frequently than one in the leg, and have found a posterior plaster slab with a turn round the wrist the best of all splints.   With this splint the veins at the elbow can be used, and they are as good as any, and better than most.

Page 15.   Drip Blood Transfusion has been brought out since the chapter on blood transfusion was written.   Certain dangers, notably haemolysis, have yet to be gone into carefully, and I am not sorry that the technique is not yet included in this work.

Page 24.   Evipan with Premedication.—I have employed evipan with a preliminary dose of hyoscine compound with most satisfactory results.   In the case of abdominal operations the abdominal wall is infiltrated with local anaesthesia in addition.

Page 101.   Continuous Aspiration of the Stomach via the Nasal Route.—With the help of Mr. Schranz, I have devised a special tube for this important measure.   It permits the nasal passages being catheterized easily, for the end of the tube is stiffened with a spring (*Fig.* 812).

Page 102.   Acute Dilatation of the Stomach.—The posture seems unimportant if the stomach is kept empty by aspiration.   In

two well-marked recent cases the patients were kept in low Fowler's position with the nasal aspirator *in situ*. A dose of eserine seemed to do good. It was used in both instances.
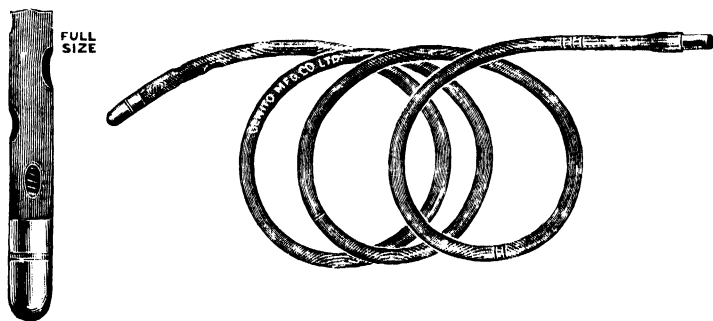
Fig. 812.—Tube   nasal route

Page 149. ACUTE PANCREATITIS.— The mortality in acute pancreatitis treated by early operation is in the neighbourhood of 50 per cent. One should, therefore, welcome the trial of an alternative procedure. *When the diagnosis is certain* delayed treatment on the lines of the Ochsner-Sherren treatment of appendicitis appears to be more than justified. Operation is only undertaken if a localized abscess forms, and then the head of the pancreas is approached preferably, but not necessarily, by the posterior route. In many cases resolution occurs, when cholecystography should be performed; if the gall-bladder is abnormal cholecystectomy is advised. Mikkelsen reports 39 consecutive cases treated on these lines with a mortality of 7·5 per cent.*

Page 226. WANGENSTEEN'S METHOD of performing jejunostomy and ileostomy is one of the most satisfactory pieces of technique it has been my good fortune to meet. In every instance the enterostomy has healed promptly after the catheter has been removed.

Page 252. IRREDUCIBLE INTUSSUSCEPTION.— So painfully infrequent is recovery after resection in any form, that if an intussusception is irreducible after Daw's method has been tried it seems wise to perform lateral anastomosis. In a number of instances when the obstruction has been thus short-circuited the gangrenous intussusception has been passed per rectum.†

* UPCOTT, H., *Brit. Med. Jour.*, 1935, ii, 567.
† SMITH, A. E., *Lancet*, 1935, ii, 992.

Page **322.** CONTINUOUS INTRAVENOUS SODIUM SULPHATE.— This is a truly marvellous diuretic, and it appears to have been instrumental in saving several lives. Again, the Glauber's salt solution must be brought to the boil before use. So far, I have only used one litre every twelve hours; the remainder of the time ordinary saline and glucose has been flowing into the vein.

Page **331.** NEPHROSTOMY.—Cabot's method is unsuited to many emergency conditions. I have drained the kidney in five or six urgent operations by making an opening with a diathermy knife through the convex border towards the pelvis. The measure has acted admirably. In one case of ruptured kidney I carried out this procedure and sutured the rent. The patient did extremely well. The rent was such that, a few years ago, I would have performed nephrectomy without hesitation.

Page **369.** DECOMPRESSION OF THE BLADDER. Kidd's U-tube is much better than the apparatus depicted in *Fig.* **345.**

Page **543.** LUDWIG'S ANGINA.— I think it best to make the curved incision over both sides of the middle line in all but the earliest cases.

INDEX

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